Issued May 26, 1913.

U. S. DEPARTMENT OF AGRICULTURE,

FOREST SERVICE—BULLETIN 126.

HENRY S. GRAVES, Forester.

FOREST PRODUCTS LABORATORY SERIES.

EXPERIMENTS IN THE PRESERVATIVE TREATMENT OF RED-OAK AND HARD-MAPLE CROSSTIES.

BY

FRANCIS M. BOND,
In Charge Wood Preservation.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1913.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Forest Service,
Washington, D. C., October 28, 1912.

Sir: I have the honor to transmit herewith a manuscript entitled "Experiments in the Preservative Treatment of Red-Oak and Hard-Maple Crossties," by Francis M. Bond, in Charge Wood Preservation, Forest Products Laboratory, and to recommend its publication as Bulletin 126 of the Forest Service.

The Chicago, Milwaukee & St. Paul Railway Co. participated in the experiments described, and the experimental treatments were made at the Forest Products Laboratory, Madison, Wis., conducted in cooperation with the University of Wisconsin. Valuable assistance was given during the course of the project by Messrs. F. J. Angier, superintendent of timber preservation, Baltimore & Ohio Railroad Co.; J. B. Card, manager, Chicago Tie & Timber Preserving Co.; H. H. Hart, general manager sales, Spencer-Otis Co.; B. Kuckuck, engineer, representing Heulsberg et Compagnie and C. Lembcke & Co.; E. Laas, formerly engineer of maintenance of way, Chicago, Milwaukee & St. Paul Railway Co.; and F. S. Pooler, tie agent, Chicago, Milwaukee & St. Paul Railway Co.

Respectfully,

Henry S. Graves,
Forester.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

ILLUSTRATIONS.

PLATES.

TEXT FIGURES.

EXPERIMENTS IN THE PRESERVATIVE TREATMENT OF RED-OAK AND HARD-MAPLE CROSSTIES.

PURPOSE AND SCOPE OF EXPERIMENTS.

A great deal has been written upon the durability of railway ties treated by the various preservative processes, but there is little available information concerning ties treated by different processes and laid in one track, where the treatments could be compared. Though for some years the Forest Service has cooperated with railway companies in tests on experimental ties in actual service,[1] these ties were all treated in commercial plants in the regular course of operation, and it was not feasible in the case of any one test to treat ties by each of the types of processes in common use.

Immediately after the establishment of the Forest Products Laboratory at Madison, Wis., however, and through the cooperation of the Chicago, Milwaukee & St. Paul Railway Co.,[2] a test track was established in which were placed ties of several species treated by a comparatively large number of representative processes. In carrying out this work the Forest Service gathered data concerning the condition and behavior of each individual tie, both before and after treatment, and of each cylinder charge as a whole during the actual treating. This was done not only to secure complete records for use in the durability tests of the ties in the track, but also to furnish information on the operation of the various processes used and, if possible, on some of the fundamental properties of wood which affect its treatment.

Part I of this bulletin describes the treatment of the ties and discusses the data of immediate value obtained during the application of the preservatives. Part II contains a description of the laying of the test track and tabulated records essential for an analysis of the durability data which will be obtained in future inspections.

THE TIES.

The species selected for the experimental ties were red oak and hard maple. On account of the limited capacity of the cylinder in which

[1] See Forest Service Circular 209, Progress Report of Service Tests of Ties, by H. F. Weiss and C. P. Winslow.

[2] By the terms of cooperation the railroad company furnished and laid the ties and paid the Forest Service an amount sufficient to cover the cost of the preservatives used.

the experimental treatments were made it was necessary to limit the total number of ties treated to the smallest consistent with reliable average results and, consequently, to limit the number of species. Red oak is a ring-porous wood and maple a diffuse-porous wood. In red oak the pores or vessels of the early wood of each annual ring are large and numerous, while in the later growth they are small and more scattered; in hard maple the pores are small and distributed uniformly throughout each year's growth. This difference in structure is well shown by the magnified cross sections in Plates I and II. Red oak is more commonly cut and treated for ties than any other ring-porous wood. Hard maple is not so extensively treated, but represents well a group the various species of which can be satisfactorily treated and utilized for crossties.[1]

The ties used in the experiments were ordinary stock of the Chicago, Milwaukee & St. Paul Railway Co. Of the red-oak ties, 225 were obtained from southern Illinois and 100 from southwestern Wisconsin; the former had seasoned two months and the latter six months prior to their shipment to the laboratory. The origin and time of cutting of the remaining red-oak ties which were treated could not be ascertained. Those placed in the track untreated were cut in the vicinity of the Tennessee River 10 months before being laid. All the hard-maple ties were from northeastern Wisconsin; those subsequently treated were cut from 6 to 18 months before their arrival at the laboratory, and those laid in the track untreated were cut just before shipment. The latter were seasoned in open piles (at the laboratory) from the beginning of April to the middle of August.

No unsound or badly checked ties were used in the experiments. A number of oaks commercially known as red oak were doubtless included, as no attempt was made to separate *Quercus rubra* from other very similar species. All bark was carefully removed from the selected ties, which were then piled for seasoning.

The 8 by 2[2] form of pile modified by placing nine ties in the two upper courses was used. The method of piling the ties for seasoning is shown in Plate III (fig. 1).

The ties used in the treatments were received during the summer and fall of 1910. The first treatments were made in October, 1910, and the last in May, 1911.

The nominal size of the ties was 6 by 8 inches by 8 feet. Most of them were hewn on two sides, but a number were sawed on three and in some cases on all four faces.

---

[1] It was first intended to use beech ties, but the maple ties were more easily procured and the species was considered as good a representative of the diffuse-porous woods.

[2] Courses of eight ties each with two ties between the courses.

THE PRESERVATIVE PROCESSES.

The preservative processes employed included at least one from each general type of pressure process in common use, in accordance with the following classification:

(1) Full-cell processes, using comparatively large amounts of creosote.

(2) So-called empty-cell processes, using small amounts of creosote, presumably well distributed in the treated portions of the wood.

(3) Processes using aqueous solutions of antiseptic salts.

(4) Processes using small amounts of antiseptic oils, together with aqueous solutions of antiseptic salts.

(5) Processes using large amounts of waterproofing oils which are nonantiseptic or practically so.

As typical of these classes of treatments the following processes[1] were selected:

(1) Full-cell creosote, using 12 pounds of creosote per cubic foot of wood.

(2) Rueping, using 5 pounds of creosote per cubic foot of wood.

(3) Burnett, using 0.5 pound of dry zinc chlorid per cubic foot of wood.

(4a) Card, using 0.5 pound of dry zinc chlorid and 4 pounds of creosote per cubic foot of wood.

(4b) Two-movement creosote-zinc chlorid, using 4 pounds of creosote per cubic foot of wood, followed by an impregnation of 0.5 pound of dry zinc chlorid per cubic foot of wood.

(5) Semirefined oil with paraffin base[2] (gas-house oil), injected into the ties until they refused to absorb more oil at a pressure of 175 pounds per square inch and a temperature of 180° F.

PART I.—TREATMENT OF THE TIES.

PLAN OF TREATMENTS.

One hundred ties of each species were treated by each of the processes named. For the treatment of each lot 10 cylinder runs were required. A charge consisted of 11 ties, of which one was cut up in order to determine the penetration of the preservative, and 10 were retained for the test track.[3] Thus, there were treated for the track 600 red-oak and 600 hard-maple ties. In addition, 100 untreated ties of each species were laid.[4]

---

[1] Established processes are designated by their trade names. Treatments which do not conform to any established process are designated in a way to indicate the general character of the treatment.

[2] It was originally intended to make similar treatments using a semirefined oil with an asphaltic base, but satisfactory arrangements could not be made for the delivery of the oil.

[3] Several charges contained only 10 ties each.

[4] Certain other ties were also included in the test track. For a full record of the track see pages 41–43.

Before the ties were placed in the treating cylinder their moisture content was calculated. So far as practicable only ties thoroughly seasoned were treated; those considered insufficiently seasoned were held for a longer period.

Plate III (fig. 2) shows the treated ties closely piled in the yard adjoining the laboratory. Each lot was piled separately, thus making 100 ties in each pile.

CYLINDER EQUIPMENT.

The arrangement of the apparatus used for the treatments is shown in figure 1. For the sake of clearness, all of the units except the

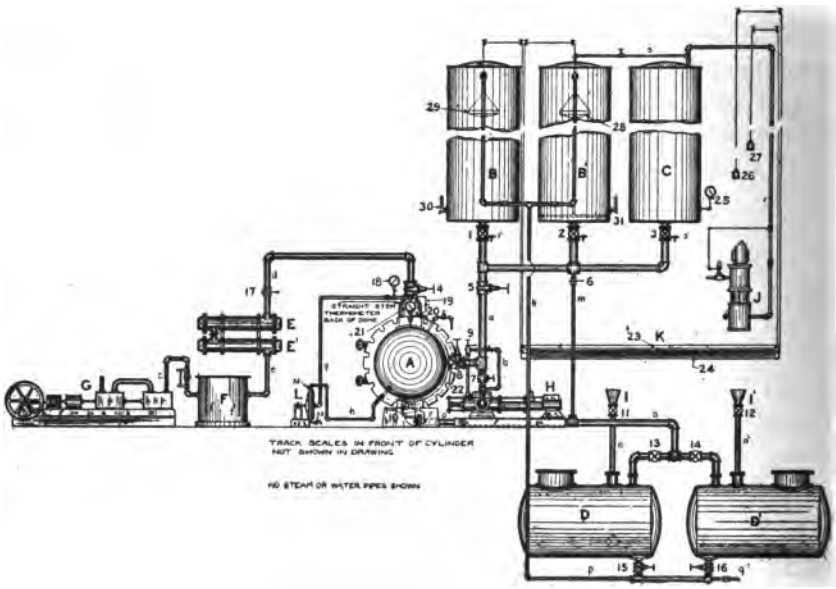
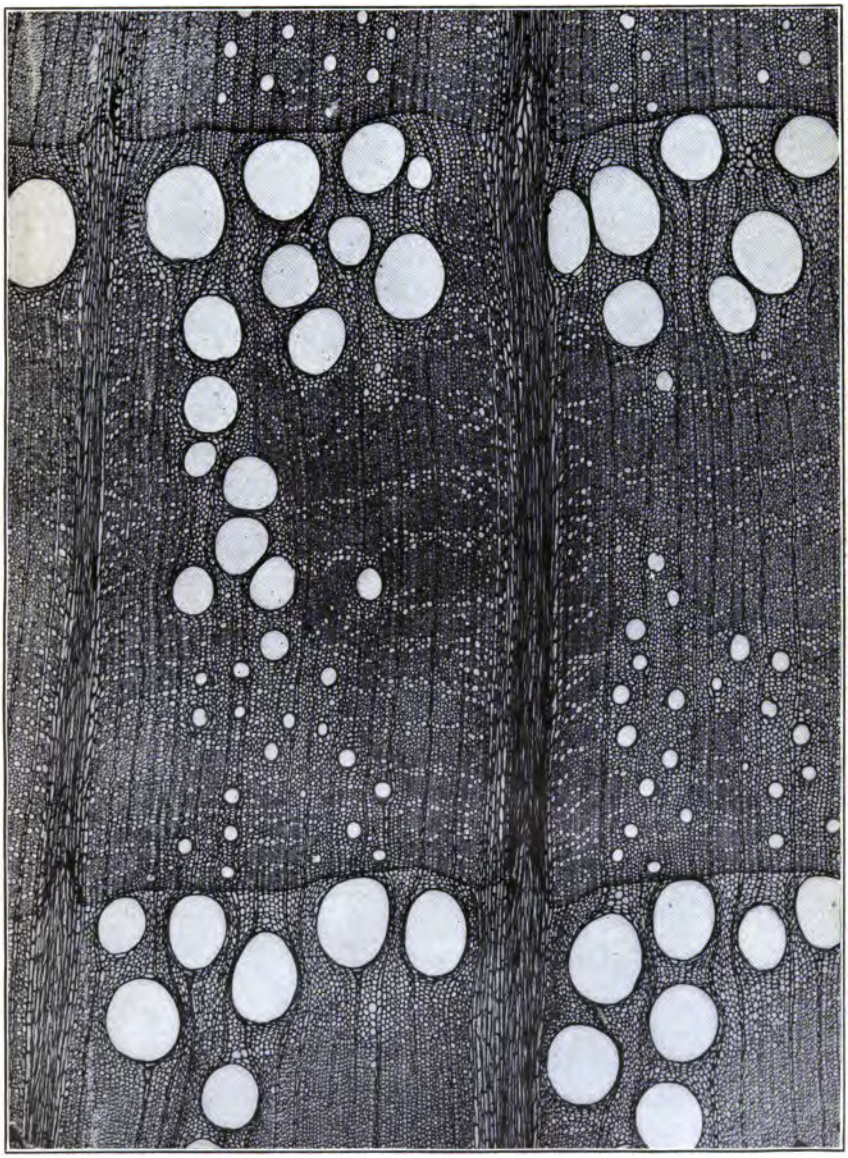


FIG. 1.—Cylinder equipment for experimental treatments.

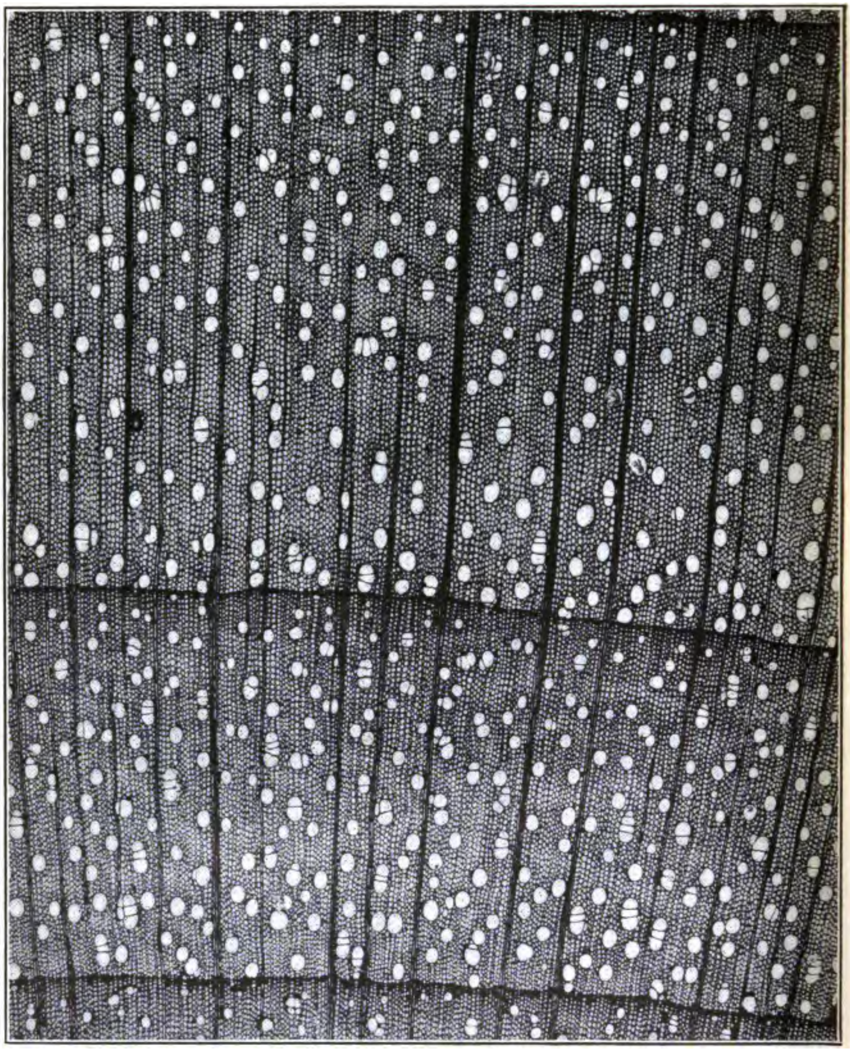
cylinder, A, are shown in side elevation; though, as actually erected, a number of them stand at right angles to the positions shown.

The principal parts of this equipment are:

Treating cylinder, A.
Track scales (in front of cylinder door; not shown in drawing).
Measuring tanks, B and B′.
Gauge board, K (for indicating the levels of floats 28 and 29).
Receiving tanks, D and D′.
Hydraulic pressure pump, H.
Surface condensers, E and E′.
Hot well, F.
Dry vacuum pump, G.
Air compressor, J.
Air receiver, C.
Motor-driven, centrifugal, circulating pump, L (motor not shown in Fig. 1).



MAGNIFIED CROSS SECTION OF RED OAK.



MAGNIFIED CROSS SECTION OF HARD MAPLE.

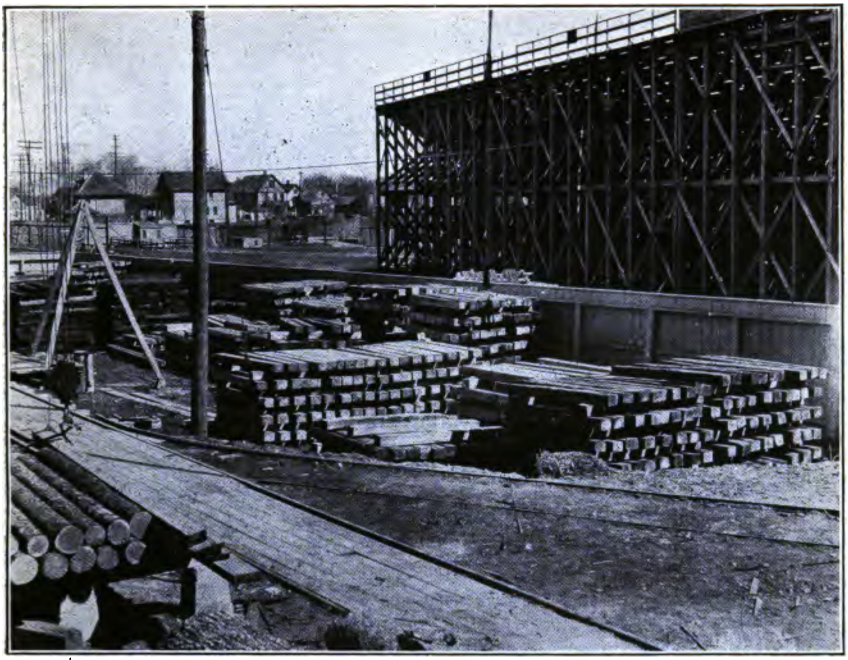


FIG. 1.—UNTREATED TIES SEASONING IN THE YARD.

FIG. 2.—TREATED TIES STORED IN THE SEASONING YARD, CLOSE-PILED, IN LOTS OF 100 EACH.

The cylinder, A, is approximately 3 feet 6 inches in diameter and 11 feet in length. It is equipped with a tramcar, tracks, and guard-rails; steam coils for heating purposes, capable of a wide range of regulation by use of reducing and throttling valves; a combination indicating vacuum and pressure gauge (21 [1]), with a platinum-protected diaphragm; an indicating vacuum gauge (18); a straight stem, separable-socket thermometer with a 3½-inch bulb, placed in the back of the cylinder (see fig. 25); and recording pressure and vacuum gauges and thermometer (not shown). Stops on the rails in the cylinder prevent the tramcar or the ties from coming in contact with the thermometer bulb. A horizontal pipe (the end shown in dotted lines near bottom of A to the left), 1 inch in diameter, runs practically the full length of the cylinder and is attached to the pipe *h*. This horizontal pipe is the end of the discharge pipe from centrifugal circulating pump, L. It enters the cylinder near the rear end, is open at the end nearest the front, and is perforated throughout its length with a row of small holes opening toward the bottom of the cylinder, but at such an angle that the discharged liquid strikes obliquely. The total area of the holes is equivalent to the area of the cross section of the pipe.

The measuring tanks, B and B′, are approximately 3 feet 6 inches in diameter and 12 feet in height. They are equipped with steam heads for heating preservatives and with separable-socket, angle-stem thermometers with 12-inch bulbs (30 and 31). Measuring tank, B′, has in addition a ¾-inch air pipe (shown in dotted lines) running down the center of the tank and branching at the bottom into a cross, each arm of which has a row of small holes opening horizontally on the right-hand side. The end of each arm is closed by a pipe cap. Compressed air passed through these pipes keeps unstable emulsions in the tank well mixed. The holes are so placed that the air begins its passage up through the liquid in spiral currents, so that those portions near the bottom of the tank are thoroughly mixed and carried upward.

The gauge board, K, with the floats (28 and 29), counterweights (26 and 27), pointers (23 and 24), and other parts is used in measuring the height of the liquid in the measuring tanks, B and B′. Its horizontal position makes it easier to read than if it were vertical. The arrangement of the gauges is shown in figure 1. A detailed sketch of the floats and a discussion of the principles of construction of the gauge are given in the appendix.

The receiving tanks, D and D′, are each equipped with steam coils and also with vent pipes, I and I′. The hot well, F, is provided with baffle plates, f and f′, directly in front of the inlet and outlet pipes, which separate suspended liquid from the air before it reaches the vacuum pump, G.

[1] This gauge is used only for reading pressures. The vacuum side is simply for convenience, since with this addition it is not necessary to turn off the gauge when a vacuum is being drawn.

THE TREATMENTS.

GENERAL METHOD OF OPERATION.

Although the ties were treated by six different processes, there are a number of features common to all of the treatments, and these will be described before taking up the details of each process separately.

With the volume of the ties and capacity of the treating cylinder known, the amount of preservative necessary to fill the free space in the cylinder and to give the desired impregnation was calculated in units of the scale on the measuring-tank gauges,[1] and the injections were regulated on this basis.

The cylinder was filled with preservative in the following way: Assuming measuring tank B (fig. 1) to contain the preservative, valves 7, 10, and 4 were closed, and valves 1, 5, 8, and 20, and cock 19 were opened. As soon as the preservative began to run out through valve 20 this was closed, and the remainder of the air in the cylinder was allowed to escape through cock 19, which was kept open until the preservative began to run out at that point. Cocks 1′, 2′, and 3′ were then opened in turn until the preservative appeared, when they were closed and the cylinder was considered full.

In order to obtain hydraulic pressure in the cylinder after it was filled, valve 8 was closed and valve 7 opened. The preservative was then drawn from pipe *a* into the pressure pump and was discharged past relief valve 9 and through check valve 22 into the cylinder. Relief valve 9 contains a valve disk held to its seat by a spring whose compression could be varied by means of an adjustable handle. When the upward pressure became sufficiently great the disk lifted, and the liquid which was thus allowed to pass through the valve was carried by pipe *b* back again to the suction pipe of the pressure pump. By means of this relief valve it was possible to maintain practically constant any pressure required.

To empty the cylinder, valve 7 was closed, valves 10, 20, 13, 14, 11, and 12 were opened, and the preservative was allowed to run into the receiving tanks by gravity. To ascertain when the cylinder was as well drained as was practicable, a valve (not shown in fig. 1) at the bottom of the cylinder near the front end was opened. In order to drain the piping system below valves 1, 2, and 3, valve 8 and cocks 1′, 2′, and 3′ were always opened before the preservative was returned from the receiving tanks to the measuring tank. However, the piping below valve 7 was always kept full when possible, being dripped only upon a change from one set of treatments to another in which different preservatives were used.

[1] All measuring-tank readings were corrected for temperature. The accuracy of the gauge readings is discussed in the appendix.

Before the admission of preservative to the receiving tanks valves 15, 16, and *q* were kept opened for several minutes in order to make sure that the receiving tanks were entirely empty. Preservative was returned from the receiving to the measuring tanks by closing valves 11, 12, and *q*, opening valves 15 and 16, and exerting an air pressure on the preservative through valves 3, 6, 13, and 14. The preservative could be returned to either of the measuring tanks.

During the treating period readings were taken at intervals of 15 minutes of the temperatures and float gauges of the measuring tanks; the temperature and pressure (or vacuum) in the cylinder; and the steam pressure in the cylinder heating coils.[1] After these readings had been recorded cock 19 was always opened in order to detect the presence of any air which might have accumulated in the dome.[2] When all of the excess preservative, including the drip, had been returned to the proper measuring tank, final readings of the measuring-tank gauge and thermometer were made.

The following are descriptions of the manner in which the various processes of treatment were conducted. In some cases departures were made in certain details from the procedure described, due to accident or other cause, but it is believed that all such changes were unimportant.

FULL-CELL CREOSOTE.

In the full-cell treatments with creosote the preservative, at a temperature of from 170° to 190° F., was at once run into the cylinder, and when this was completely filled the pressure pump was started. An initial pressure of 50 pounds per square inch was obtained as soon as possible and was held for 15 minutes. The pressure was then increased in steps of 25 pounds per square inch, at intervals of 15 minutes, until an absorption of approximately 12 pounds per cubic foot of wood was indicated by the measuring-tank gauges. If, however, a pressure of 175 pounds per square inch was reached before the desired absorption was secured, this last pressure was maintained until an absorption of 12 pounds per cubic foot was indicated. The oil was then run from the treating cylinder into the receiving tanks, and a vacuum was maintained for 30 minutes to dry the ties. The gauge showed a vacuum of 26 inches of mercury in about 15 minutes. The cylinder was then drained again into the receiving tanks and the charge removed. The maximum temperature of the oil in the cylinder was approximately 180° F.[3]

---

[1] While the recording gauges and thermometer were operated during the treatments, they were used only as checks on the simple indicating instruments.

[2] However, in no case during the treatments described in this bulletin was the presence of air in the dome observed during the pressure period. The length of the pipe from the cock to its open end was approximately 5 feet, and its diameter three-eighths of an inch.

[3] Some variations from this procedure (principally in pressure) were made in the full-cell creosote treatments in the case of several re-treatments of ties previously treated by the Rueping process with an unsuitable amount of creosote. The total absorption of these ties was, however, the same as in the case of the full-cell creosote-treated ties which received but one treatment.

RUEPING.

In the treatments by the Rueping process an air pressure of 50 pounds per square inch for red oak and 90 pounds per square inch for hard maple was at once applied to the ties. The duration of the air bath was in no case less than 10 minutes, after which, without reducing the pressure, the cylinder was pumped full of creosote at a temperature of from 170° to 190° F., the compressed air being released through vent pipes 19 and 20 (fig. 1). When the cylinder was completely filled with creosote the pressure was increased in steps of 25 pounds per square inch, held for 15 minutes each, until the maximum pressure was reached. In the case of red oak this was 175 pounds per square inch, and in the case of hard maple 140 pounds per square inch.[1] The maximum pressure was then maintained until the measuring-tank gauge, by two readings 15 minutes apart, showed no further absorption of creosote by the ties. After releasing the pressure and dropping the creosote into the receiving tanks a vacuum was drawn and held for 30 minutes, the gauge showing a vacuum of 26 inches of mercury in about 15 minutes. The cylinder was then again drained and the ties were removed.

With the air and oil pressures used, an average absorption of approximately 5 pounds of creosote per cubic foot of wood was obtained. The maximum temperature in the cylinder during the treatment was approximately 180° F.

BURNETT.

In applying the Burnett process a preliminary vacuum of 26 inches of mercury was drawn and held for 30 minutes, after which, without breaking the vacuum, an aqueous solution of zinc chlorid at a temperature of 130° to 140° F. was run into the cylinder by gravity. This solution was of a concentration of 3 per cent in the case of red-oak ties, and 2.5 per cent in the case of hard maple. When the cylinder had been completely filled with the solution the pressure pump was started, and a pressure of 50 pounds per square inch was obtained at once and maintained for 15 minutes. The pressure was then increased in steps of 25 pounds per square inch, held for 15 minutes each, until a sufficient amount of the solution had been absorbed to give an average impregnation of approximately 0.5 pound of the dry salt per cubic foot of wood. If this impregnation was not secured before a pressure of 200 pounds per square inch was reached, the pressure was maintained at this figure until the proper absorption was indicated. The solution was then run from the cylinder, and the ties were allowed to drip for at least 15 minutes, after which they were removed. The average temperature of the cylinder during treatment was approximately 160° F.

[1] The proper air and oil pressures required in order to obtain the desired absorption in the two species was determined by preliminary tests.

CARD.

Treatments by the Card process were applied as follows: An emulsion consisting of a 3 per cent aqueous solution of zinc chlorid and creosote in the proportion of 80 per cent of zinc-chlorid solution to 20 per cent of creosote, by volume (at approximately 70° F.), was kept mixed in the measuring tank at a temperature of approximately 190° F. by blowing air through it. The emulsion in the treating cylinder was agitated by means of a centrifugal circulating pump, the capacity and speed of which were such that a volume equal to the quantity of emulsion in the cylinder was passed through it approximately every 15 minutes.

A vacuum of at least 26 inches of mercury was drawn and held for one hour, and the emulsion was admitted into the cylinder without breaking the vacuum. When the cylinder was completely filled the pressure pump was started, and a pressure of 50 pounds per square inch was obtained at once and held for 15 minutes. The pressure was then increased in steps of 25 pounds per square inch, held for 15 minutes each, until an absorption of approximately 0.5 pound of dry zinc chlorid and 4 pounds of creosote (20 pounds of emulsion) per cubic foot of wood had been obtained, or until a maximum pressure of 175 pounds per square inch had been reached, to be held until the desired absorption was secured. After emptying the cylinder a vacuum of at least 26 inches of mercury was drawn and held for 30 minutes, after which the cylinder was again drained and the ties removed. The average maximum temperature of the cylinder during treatment was approximately 180° F.

Samples of the emulsion were taken before, during, and after each treatment, both from the measuring tank and from the treating cylinder at a point 2 feet from its rear end in its axis.[1] Great care was exercised to maintain the proper proportions of zinc-chlorid solution and creosote in the emulsion.

TWO-MOVEMENT CREOSOTE-ZINC CHLORID.

A treatment consisting of separate injections of creosote and zinc chlorid was made as follows: Creosote at a temperature of from 180° to 200° F. was at once run into the cylinder until the uppermost ties in the charge had been submerged approximately 2 inches, as shown by a gauge glass. The inlet valve to the cylinder was then closed and the temperature of the creosote raised to 212° F., the expansion of the oil being taken care of by an overflow pipe leading from the top of the cylinder to the receiving tanks.[2] The ties were kept submerged in creosote at a temperature of approximately 212°

[1] The manner of analyzing these samples is described in the appendix.

[2] This excess oil was returned to the measuring tank with the creosote in the cylinder at the end of the heating period.

F. for a period of 30 minutes, after which the creosote was drained into the receiving tanks.[1] During the heating period a connection was kept open to the surface condensers, but no appreciable amounts of condensed vapors were obtained. Care was taken to prevent a drop in temperature after the creosote had reached 212° F., which would have caused a contraction and a possible uncovering of the uppermost ties in the charge. On this account the temperature was raised slightly and very gradually during this part of the treatment.

At the end of the hot bath the creosote was drained from the cylinder as completely as practicable, and a 3 per cent aqueous solution of zinc chlorid at a temperature of from 160° to 180° F. was run into it. When the cylinder was completely filled the pump was started, and a pressure of 50 pounds per square inch was obtained at once and held for 15 minutes. The pressure was then increased in steps of 25 pounds, held for 15 minutes each, until an absorption of the solution corresponding to an impregnation of 0.5 pound of dry zinc chlorid per cubic foot of wood was obtained, or until a maximum pressure of 175 pounds per square inch had been reached, to be maintained until the desired absorption was secured. The zinc-chlorid solution was then run into the receiving tanks, and after a 15-minute dripping period under atmospheric pressure the ties were removed from the cylinder. The average maximum temperature of the cylinder during the pressure period was approximately 180° F.

GAS-HOUSE OIL.

In the treatments with gas-house oil a vacuum of 26 inches of mercury was at once drawn and maintained for 15 minutes. The preservative was then run in at a temperature of from 150° to 170° F. When the cylinder was completely filled the pressure pump was started, and a pressure of 50 pounds per square inch was obtained at once. The pressure was then increased by steps of 25 pounds, held for 15 minutes each, until a maximum pressure of 175 pounds per square inch was reached. This was continued until two successive readings of the measuring tank gauge, taken 15 minutes apart, showed no further absorption. The oil was then run into the receiving tanks, and a vacuum of 20 inches of mercury was drawn and maintained for 15 minutes, after which the cylinder was drained into the receiving tanks and the ties were removed and weighed at once.[2] The average maximum temperature of the cylinder during the pressure period was approximately 180° F.

[1] In this process the ties were drained after the hot creosote bath for a longer period than in the other processes used, in order to reduce as much as possible the contamination of the zinc-chlorid solution with creosote.

[2] The final vacuum was omitted in a few of the cylinder charges.

DETERMINATIONS MADE.

VOLUME OF TIES.

The apparatus used in determining the volumes of ties is shown in figure 2. The tie is submerged in water, and the difference in the level of the water during and after submersion is a measure of its volume. The water level is read in the gauge glass shown at the side of the tank. In order to make the reading more accurate a "rider" (fig. 3) was used. By bringing the upper edge of the two horns of the rider and the lowest part of the meniscus, or surface of the water in the gauge glass, in the same plane, parallax was avoided.

The gauge glass was graduated in 0.01 foot and read to the nearest 0.005 foot; volume of the tank was 1.72 cubic feet for each foot in depth.

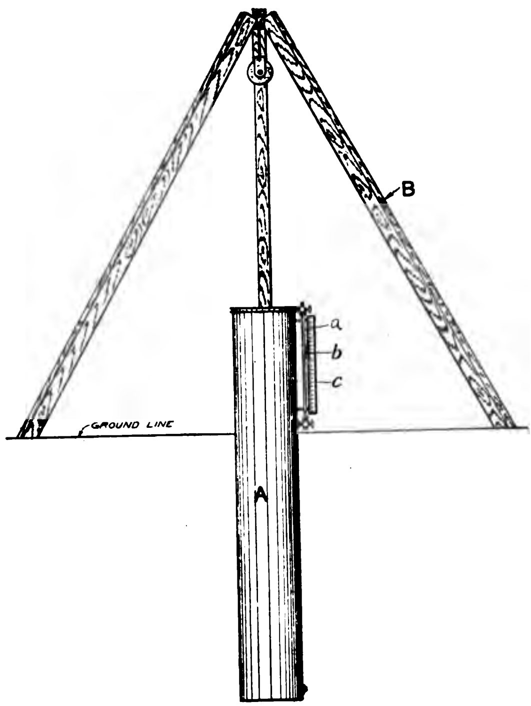


FIG. 2.—Apparatus used in determining volumes of ties.

OVEN-DRY WEIGHT.

The oven-dry weight of each tie was determined by means of a section approximately 1 inch thick cut from one end.[1] The green or wet volume of each section was determined, and the section was then dried in an oven and weighed. From these values the dry weight of the tie was computed.

The volumes of the sections were obtained from the weight of the water they displaced. The apparatus shown in figure 4 consists essentially of a vessel of water placed on the weighing platform of a balance and an arm (separate from balance and vessel) by means of which the wood is submerged. The difference in the weight of the vessel before and after the immersion of the section is the weight of the water displaced.[2] The weighings were made to the nearest one-half ounce.

[1] These sections were cut before the volumes of the ties were determined.
[2] This weight is supplied by the weight of the disk plus the pressure required to submerge it.

Before making this determination the sections were soaked in water until they had reached a constant volume.[1] This was done in order that their volumes might be more nearly comparable to the volumes of the ties; most of the latter were only partially seasoned when their volumes were determined, and when treated had a moisture content usually above the point (30 per cent) where any considerable shrinkage takes place.

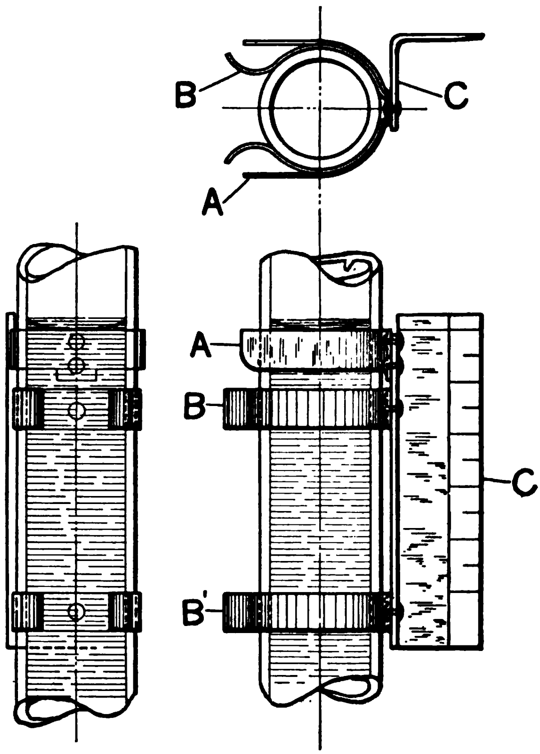


FIG. 3.—Rider used on gauge glass to determine level of liquid in tank shown in figure 2.

After their volumes had been determined the sections were air-dried in the laboratory for several days, then dried in an oven at 100° C. until they showed no change in weight over a period of 24 hours, when they were considered air-dry.

MOISTURE CONTENT.

Having determined the actual weight of the tie and its computed oven-dry weight the amount of moisture it contained was found by subtraction after both factors had been reduced to pounds per cubic foot, and the moisture content was computed as a percentage of the oven-dry weight of the wood. The moisture content of all ties was found immediately before they were placed in the treating cylinder.

PERCENTAGE OF SAPWOOD.

The area of both the entire cross section and of the heartwood portion of the sections cut for oven-dry weight determinations was measured with a planimeter, and from these measurements the per-

[1] The sections were cut from the ends of the ties and therefore contained less moisture than the average for the entire tie; moreover, they would dry rapidly between the time they were cut and the time when the volumes were determined.

centage of sapwood was calculated.[1] No attempt was made to cut the sections from corresponding ends of the ties; that is, the ends having the same relative position with respect to the butts of the trees from which they were cut. Because of the variation in the percentage of sapwood between the two ends of a given tie the method of measurement used is regarded as an estimation only.

RATE OF GROWTH.

The rate of growth of the ties was obtained in the ordinary manner; that is, by actual count of the number of annual rings in a measured

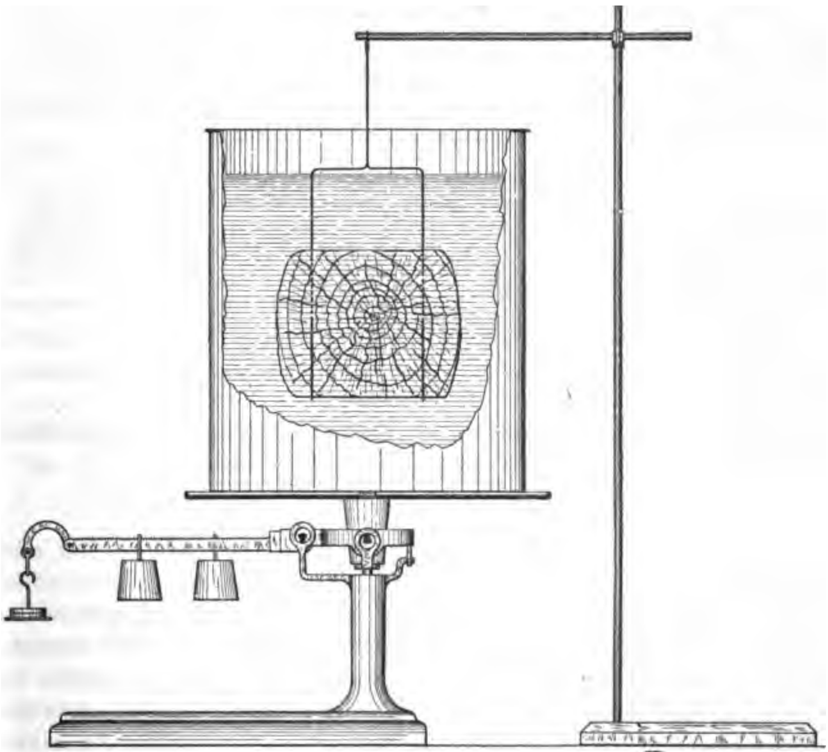


FIG. 4.—Method of determining volume of tie sections.

radial distance. The radius along which the count was made was in all cases selected as most representative of the section.

[1] The tie sections were placed beneath a thin sheet of glass upon which two cross marks had been made with an ordinary glass cutter. One of these was used as the point of rotation and the other as the origin for the tracing point of the planimeter. Care was taken to prevent the measuring wheel from slipping on the glass, frequent checks being made with this in view. The glass was carefully wiped off before each determination in order to remove the dust, which might cause the measuring wheel to slip. Where there was any difficulty in distinguishing the line between the heartwood and sapwood the section was dipped into water to bring out the line more clearly.

ABSORPTION OF PRESERVATIVES.

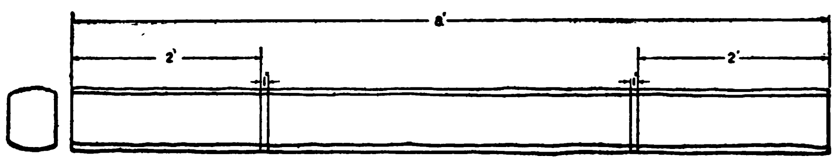
Although the tank gauges were read during the treatments, the absorptions recorded in this bulletin are those determined by weighing the ties before and after treatment. The weighings were made on a track scale, the beam of which was graduated in pounds. Weights of individual ties were obtained by balancing the scales as each tie was placed on the tram. In all cases the treated ties were weighed immediately after they were drawn from the cylinder.

PENETRATION OF OILS.

In order to determine the average penetrations of the oils, that tie in each cylinder charge which showed an absorption nearest the average for the whole charge was sawed into sections, as shown in figure 5. The middle and the two end sections of each of these ties were then split and the penetrations of the oils noted.

DISTRIBUTION OF ZINC CHLORID.

With a few exceptions one of the 1-inch sections cut from the tie of average absorption in each cylinder charge of the Burnett, Card, and



DIMENSIONS — APPROXIMATE

FIG. 5.—Method of sawing ties to determine penetration in those of average absorption.

two-movement creosote-zinc-chlorid processes was finely ground, and, after being thoroughly stirred, was analyzed to determine the amount of zinc chlorid present at that point in the ties most important in regard to their durability—near the rail fastenings. The samples were not considered as necessarily representative of the entire tie. The wood was digested by means of nitric and sulphuric acids and potassium chlorate, and the zinc chlorid in the residue remaining after digestion was determined by titration.[1]

RESULTS.

TIME REQUIRED FOR TREATMENT.

COMPARISON OF PROCESSES.

Table 1 shows the average time of treatment of red-oak and hard-maple ties by each of the processes used. In most cases the value given is the average of 10 runs; in a few instances one or more of the

[1] The details of this method of analysis and the actual analyses were worked out by Mr. E. Bateman, chemist in forest products.

10 runs made are omitted from the average because of irregularities in the procedure or in the results.[1]

The manner of operation in each of the various treatments was in accordance with the advice of some authority on the particular process. Since the same economy of time was not observed in the various steps of each process, it is manifestly unfair to make any comparison of the various processes based on the time of treatment.

COMPARISON OF SPECIES.

For all processes except the full-cell creosote,[2] the average time required for the treatment of red oak was 4 hours 29 minutes, and of maple 3 hours 46 minutes. Therefore, on an average, 19 per cent more time was required for the oak than for the maple ties. This may have been due largely to the more even distribution of vessels and the more open nature of the wood fibers of maple, as shown in Plates I and II, and also to the fact that the oven-dry weight of the maple was less than that of the red oak.

The difference in the time required for the treatment of the red-oak and the hard-maple ties by the two-movement creosote-zinc-chlorid process was considerably less than in the case of any other process. This seems to have been due to the fact that the resistance offered by the hard-maple ties to the injection of zinc-chlorid solution was largely increased by the creosote which had been absorbed by the wood during the boiling period. No such equalization of the time required for treatment of the two species was effected by the injection of the creosote and zinc chlorid in an emulsion by the Card process.

VARIATION IN ABSORPTION.

COMPARISON OF PROCESSES.

The average results of treatments afford little basis for a comparison of the ease with which the desired absorptions are attained by the various processes. Omitting the Rueping (empty-cell) process, the smallest absorption was obtained with gas-house oil and the highest with straight zinc-chlorid solution (Burnett process). The creosote and zinc-chlorid emulsion (Card process) and the two-movement zinc-chlorid and creosote treatments gave practically the same absorptions, and were only slightly below the Burnett treatment. These relations hold for both species, but in the maple the absorptions are uniformly greater than in the oak, omitting the Rueping process as before.

The mean average variation of absorption of ties in the same charge varied with the different processes, but does not show con-

[1] A summary of results of the treatments for each cylinder charge is given in the appendix in Table 13.

[2] Because of the fact that some of the full-cell creosote-treated ties were re-treated, it would not be fair to include them in this average.

sistent variation for both species. Considering the two species, the variation is greatest for the gas-house oil treatments and least for the Burnett process.

COMPARISON OF SPECIES.

The average variation in absorption of ties in the same charge was greater for hard maple than for red oak, except in the case of the Rueping and the gas-house oil treatments. In the Rueping process the difference in this variation for the two species is small. In the gas-house oil treatments on red oak a large variation was to be expected because of the refractory nature of this lot of ties, which were mostly cut from the heartwood of comparatively old trees, and were of comparative high moisture content.

In the case of red oak, the tie of highest absorption in a given charge varied more from the average than the tie of lowest absorption.[1] In other words, there was less likelihood of having excessively low than excessively high absorptions in a given charge of red-oak ties. A study of Table 1 will show no marked difference of this kind in the maple ties.

PENETRATION OF OILS.

Three representative ties of each species from each process using oils were selected, and photographs were made of a cross section and a split surface of a part of the middle section of each tie. These photographs, taken immediately after the sections were freshly surfaced, are reproduced in Plates IV to VIII.

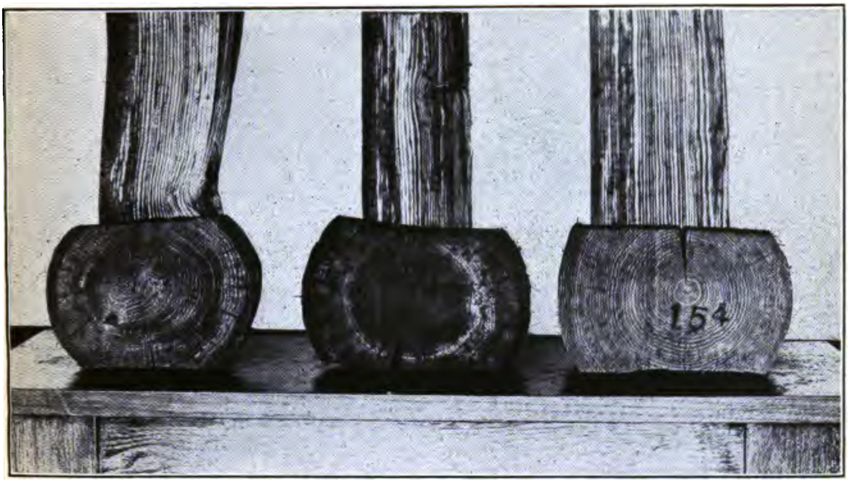
Plate IV shows the complete penetrations of the vessels of red oak secured in the treatments by the full-cell creosote and the Rueping processes.[2] The only apparent difference in the fresh surfaces of the two lots of ties was that those treated by the full-cell creosote process were darker in color because of the much larger quantity of creosote present.

Plate V shows the penetrations secured in the treatment of hard-maple ties by the same processes. In both treatments the penetration of preservative was almost entirely in the sapwood. The maple ties treated by the full-cell creosote process seemed to show little better penetrations than those treated by the Rueping process, but many of the latter were cut from large trees and contained more heartwood on the faces. Considering the variability of the ties, there was little difference in the penetrations obtained by the two processes. The heavy absorption about the knot in tie No. 487 (Pl. V) is of interest.

Plates VI and VII illustrate the penetrations of creosote which were secured in red-oak and hard-maple ties treated by the Card

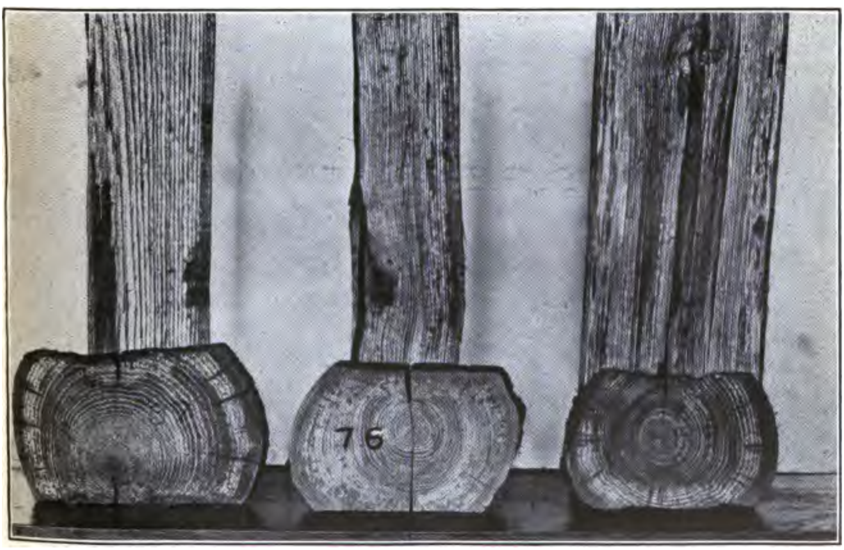
[1] This was not true of the Card treatments, but the cause is probably to be found in the variability of the material rather than in any difference in the behavior of the process.

[2] The presence of creosote in the vessels of red oak will doubtless insure a protection of the adjacent fibers which are not impregnated.



Tie No. 194. Tie No. 185. Tie No. 154.

FIG. 1.—SECTIONS OF RED-OAK TIES TREATED BY THE FULL-CELL CREOSOTE PROCESS.

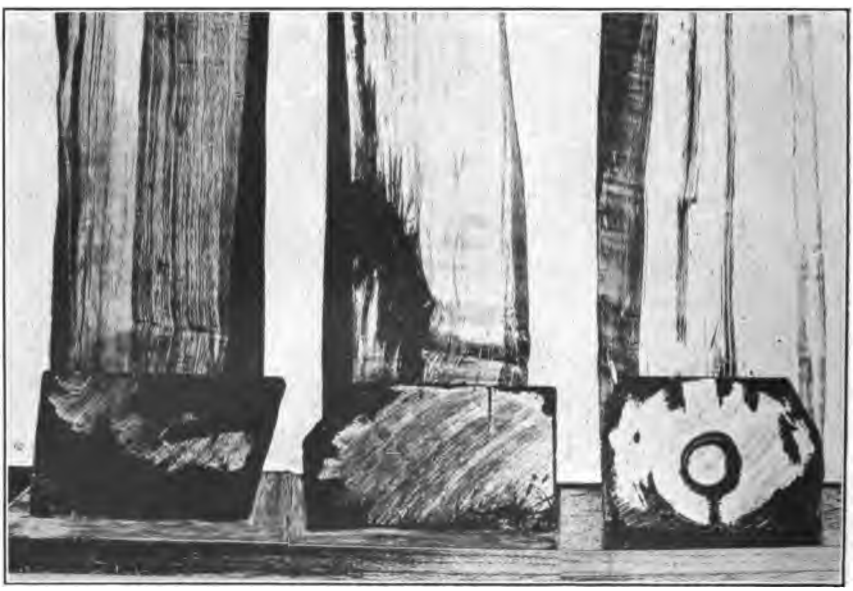


Tie No. 67. Tie No. 76. Tie No. 58.

FIG. 2.—SECTIONS OF RED-OAK TIES TREATED BY THE RUEPING PROCESS.

Tie No. 548. Tie No. 594. Tie No. 565.

FIG. 1.—SECTIONS OF HARD-MAPLE TIES TREATED BY THE FULL-CELL CREOSOTE PROCESS.



Tie No. 434. Tie No. 487. Tie No. 467.

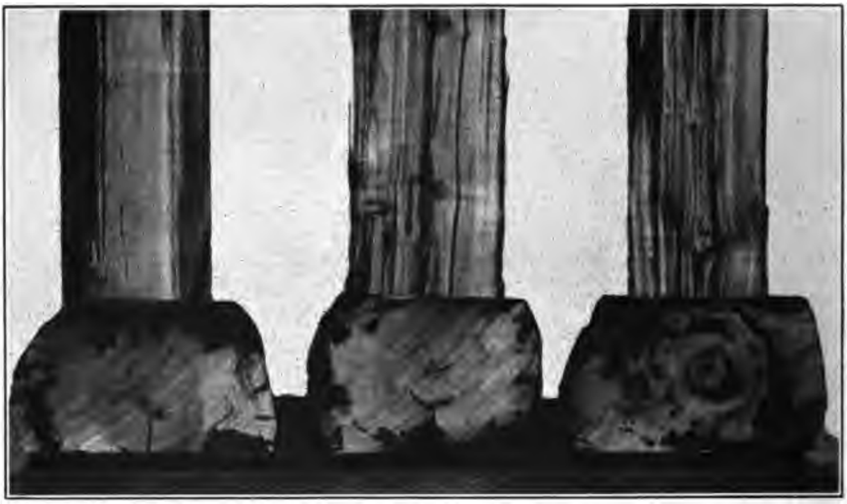
FIG. 2.—SECTIONS OF HARD-MAPLE TIES TREATED BY THE RUEPING PROCESS.

Tie No. 1204. Tie No. 1244. Tie No. 1232.

FIG. 1.—SECTIONS OF RED-OAK TIES TREATED BY THE CARD PROCESS.

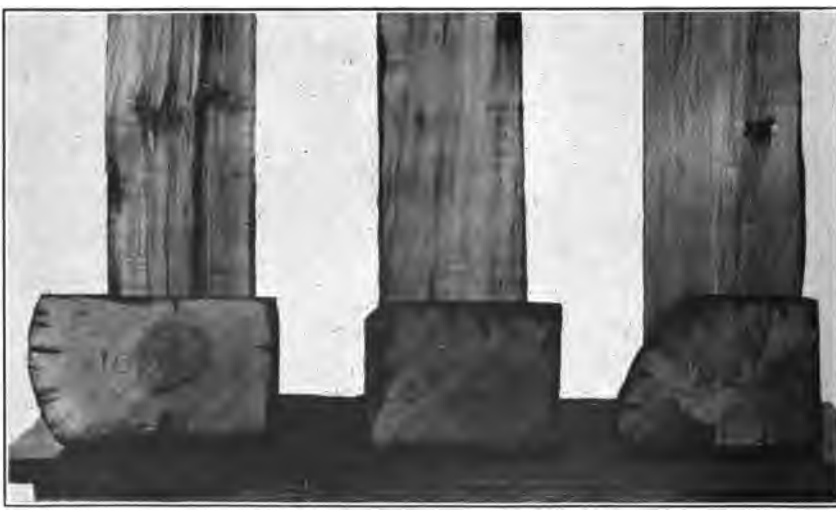
Tie No. 856. Tie No. 863. Tie No. 894.

FIG. 2.—SECTIONS OF RED-OAK TIES TREATED BY THE TWO-MOVEMENT CREOSOTE-ZINC-CHLORID PROCESS.



Tie No. 1157. Tie No. 1178. Tie No. 1165.

FIG. 1.—SECTIONS OF HARD-MAPLE TIES TREATED BY THE CARD PROCESS.

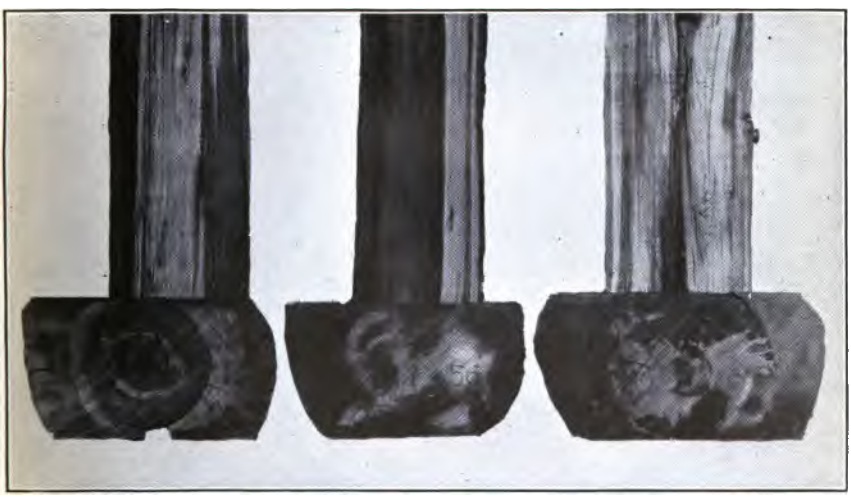


Tie No. 1016. Tie No. 1003. Tie No. 1021.

FIG. 2.—SECTIONS OF HARD-MAPLE TIES TREATED BY THE TWO-MOVEMENT CREOSOTE-ZINC-CHLORID PROCESS.

Tie No. 648. Tie No. 689. Tie No. 616.

FIG. 1.—SECTIONS OF RED-OAK TIES TREATED WITH GAS-HOUSE OIL.



Tie No. 1446. Tie No. 1456. Tie No. 1468.

FIG. 2.—SECTIONS OF HARD-MAPLE TIES TREATED WITH GAS-HOUSE OIL.

and the two-movement creosote-zinc-chlorid processes. In the red-oak ties there seems to be a somewhat greater penetration of creosote by the Card than by the two-movement process; this difference is more marked in the hard-maple ties. In this case, also, part of the difference shown by the maple ties may be accounted for by the variability in the amount of sapwood. It should be remembered that these processes depend for their efficiency largely upon the zinc chlorid, and that the creosote is used principally to retard the leaching out of the salt. The penetration of the zinc chlorid can not be seen in the illustrations.

In Plate VIII the penetrations secured in treatments with gas-house oil are shown. The penetrations secured in the hard-maple ties were the most complete of any of the treatments of maple with oils. This is accounted for by the low viscosity of the oil in comparison with creosote. While the penetration of the gas-house oil in the red oak seems to have reached to the centers of the ties, it was in streaks. However, as has been said, these ties were more refractory than the other lots of the same species.

The great difference in the uniformity of penetrations in red-oak and hard-maple ties indicated by Plates III to VII should be especially noted. The greater variability in penetration of the maple accords with the variability in absorption indicated in Table 1.

TABLE 1.—*Summary of results of tie treatments for each process.*

Treatment.	Species.	Total time of treatment.	Average absorption per cubic foot.	Variation from average absorption.		
				Average variation for all ties in charges.	Average variation for ties of highest absorption in each charge.	Average variation for ties of lowest absorption in each charge.
		H. m.	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*
Full-cell creosote	Red oak	4 28	10.9	15.4	38.4	27.2
Do	Maple	2 36	12.0	18.6	45.5	36.4
Rueping	Red oak	4 10	5.3	19.9	49.8	40.8
Do	Maple	3 27	4.9	18.3	34.8	35.9
Burnett	Red oak	4 23	[1] 16.9	13.8	34.8	27.4
Do	Maple	2 56	[2] 20.6	16.8	34.7	35.9
Card	Red oak	5 21	[3] 15.3	13.7	25.0	30.7
Do	Maple	4 48	[3] 16.0	20.6	45.1	35.2
Two-movement $ZnCl_2$ and creosote	Red oak	4 00	[4] 15.3	12.3	28.5	27.8
Do	Maple	4 05	[4] 15.5	17.1	29.2	37.6
Semirefined oil, paraffin base	Red oak	4 32	7.3	27.2	54.9	50.3
Do	Maple	3 36	12.6	23.3	46.8	41.6

[1] 3 per cent $ZnCl_2$ solution.
[2] 2½ per cent $ZnCl_2$ solution.
[3] Emulsion of 80 parts of 3 per cent $ZnCl_2$ solution and 20 parts of creosote by volume at approximately 70° F.
[4] 3 per cent $ZnCl_2$ solution plus creosote.

DISTRIBUTION OF ZINC CHLORID.

The average amount of zinc chlorid per cubic foot found by analysis of the sections cut 2 feet from the ends of the ties was 13.5 to 15.4 and 25 to 26.6 per cent less for the oak and maple, respectively,

than that computed from the absorptions of the ties. The averages of the determinations made are given in Table 2, and the results for each tie are given in Table 14 of the appendix.

The differences between the zinc-chlorid content computed from the absorptions of the ties by analysis of the sections are very uniform for the three classes of treatment. While the method of sampling used gives little information on the distribution of the preservative, the inference is that the distribution in the three classes of treatments is equally good. The greater difference shown by the maple ties compared with the red oak in the absorptions found by the two methods of determination indicates a less satisfactory longitudinal penetration for maple, a large amount of salt presumably being in the ends of the ties.

TABLE 2.—*Average amount of zinc chlorid in the ties of average absorption.*

Treatment.	Species.	Absorption, dry salt per cubic foot.		Difference between calculated absorptions for ties and absorptions determined in sections.
		Calculated from amount of solution absorbed by ties.	Determined by analyses of sections 2 feet from end of ties.	
		Pounds.	*Pounds.*	*Per cent.*[1]
Burnett	Red oak	0.52	0.45	13.5
Do	Maple	.49	.36	26.6
Card	Red oak	.39	.33	15.4
Do	Maple	.39	.29	25.6
Two-movement $ZnCl_2$ and creosote	Red oak	(²)	.27	
Do	Maple	[3].40	.30	25.0

[1] Based on calculated absorptions for the ties.
[2] The measuring-tank gauge readings disagreed so greatly with absorption by weights that the proportion of $ZnCl_2$ solution could not be calculated.
[3] Calculated from the absorption of $ZnCl_2$ solution shown by measuring-tank readings. The sum of the absorption of creosote and the absorption of $ZnCl_2$ solution by measuring-tank readings differed from total absorption by weight by 1 per cent when all ties in this treatment are averaged.

RELATION BETWEEN WEIGHT AND ABSORPTION.

In order to ascertain, if possible, the effect of differences in weight of the ties on absorption each charge was investigated in the following manner: The absorption of each tie in a single charge was plotted in the order of its magnitude, beginning with the tie of lowest absorption. Vertically above each absorption the corresponding oven-dry weight of the wood per cubic foot, the moisture per cent, and the total weight per cubic foot of the wood before treatment (called the "treating weight") were plotted. The resultant curves for each cylinder charge were averaged in each process, and these curves, for both oak and hard maple, are shown in figures 6 to 17. In the case of red-oak ties (figs. 6 to 11) it is very evident that the less the treating weight the greater is the absorption. In all except the Rueping and gas-house oil treatments this is very marked, and even in the latter processes there is the same tendency, although to a less degree. It is

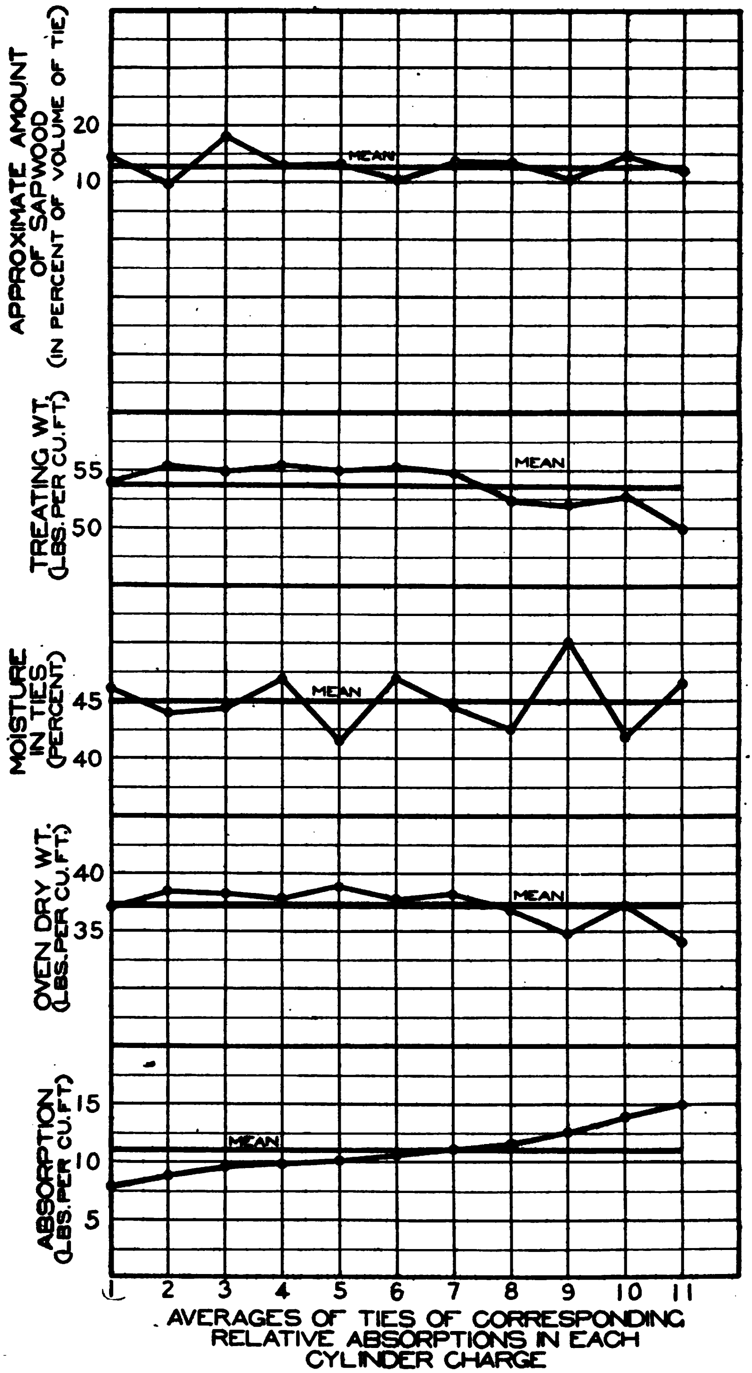


FIG. 6.—Relation of weight of wood, moisture content, and per cent of sapwood to absorption in red-oak ties treated by the full-cell creosote process.

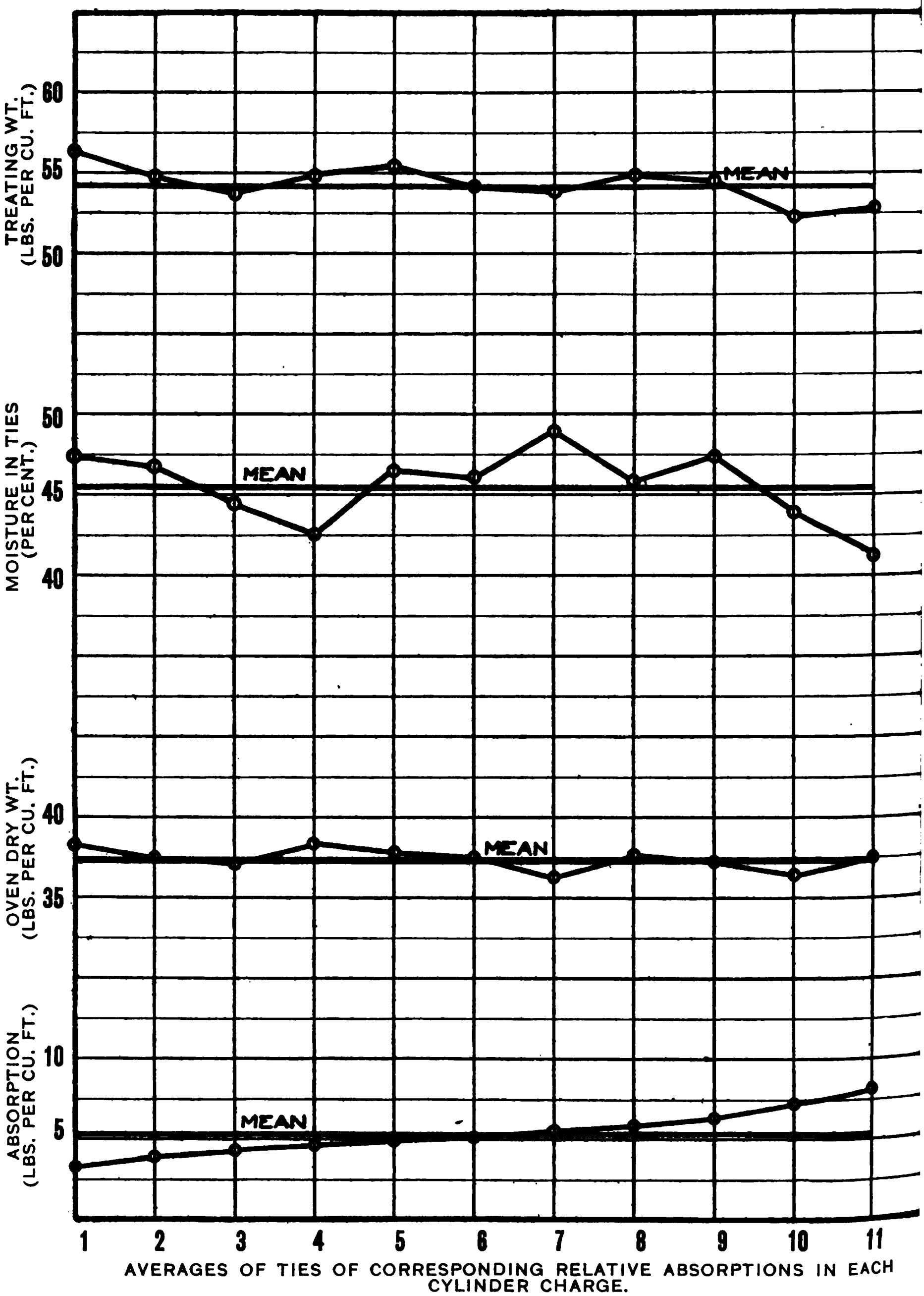


FIG. 7.—Relation of weight of wood and moisture content to absorption in red-oak ties treated by the Rueping process.

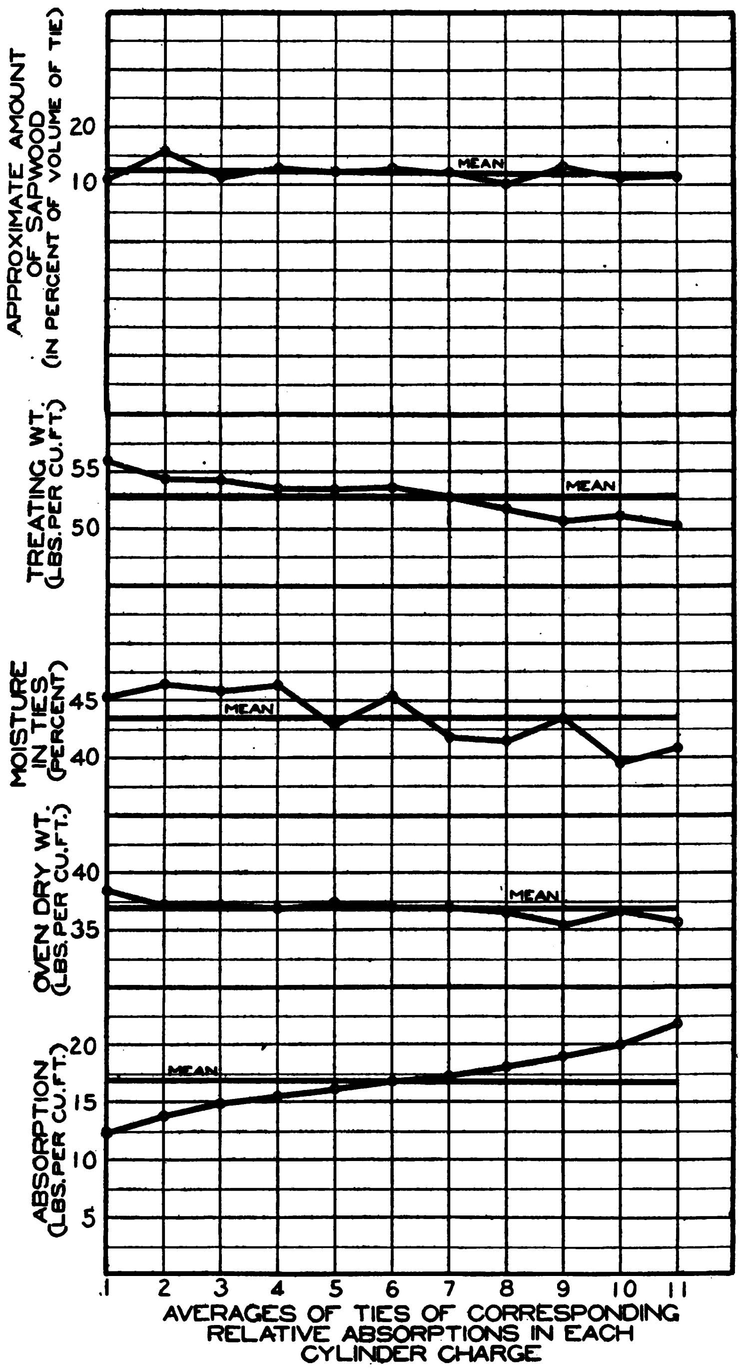


FIG. 8.—Relation of weight of wood, moisture content, and per cent of sapwood to absorption in red-oak ties treated by Burnett process.

seen also that in general the less the oven-dry weight of the wood and the moisture per cent before treatment, the greater is the absorption.[1]

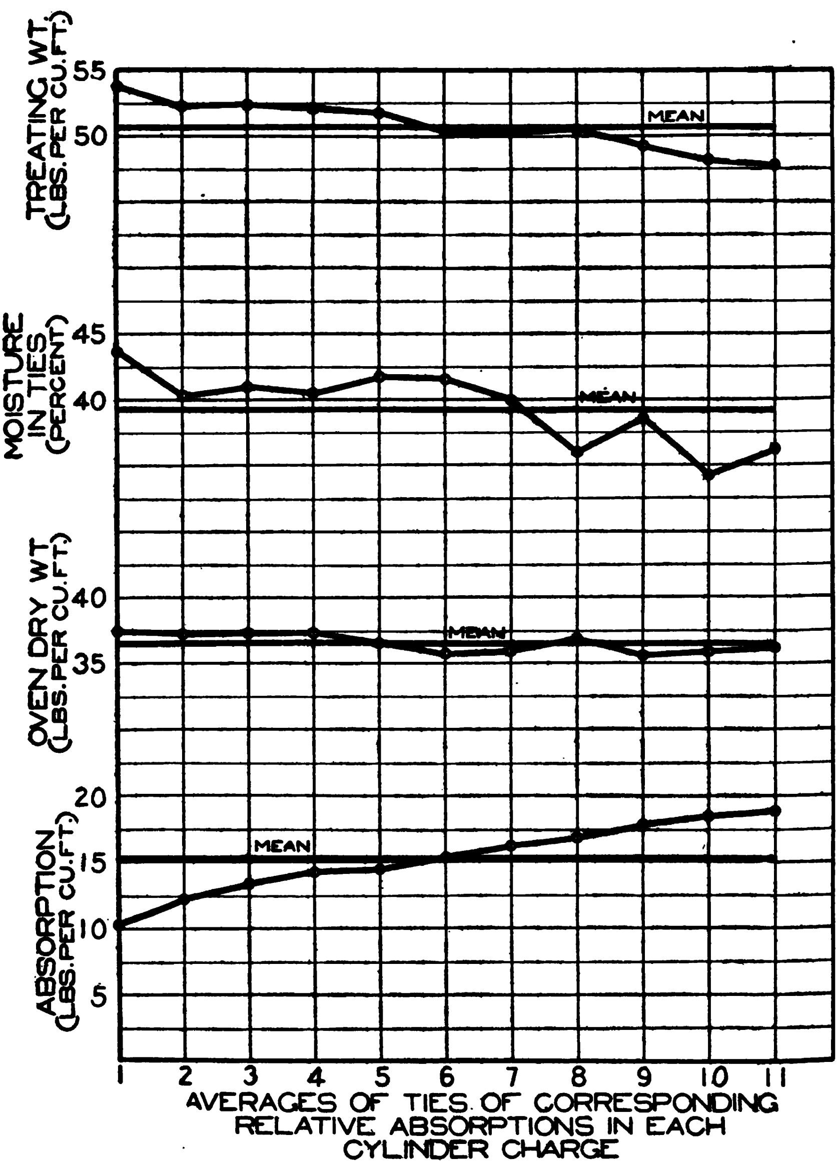


FIG. 9.—Relation of weight of wood and moisture content to absorption in red-oak ties treated by Card process.

The exceptions noted are undoubtedly a result of the variability in the material, and are not a result of the process used.

[1] The treating weight equals the oven-dry weight plus the weight of moisture in the wood.

For hard-maple ties (figs. 12 to 17) it is evident that with a rise in the curves for absorption there is a marked downward tendency in the curves for treating weight and oven-dry weight in the full-cell creosote, Card, and gas-house oil treatments, and also in a less degree in the Burnett treatment. The curves for moisture per cent seem to have

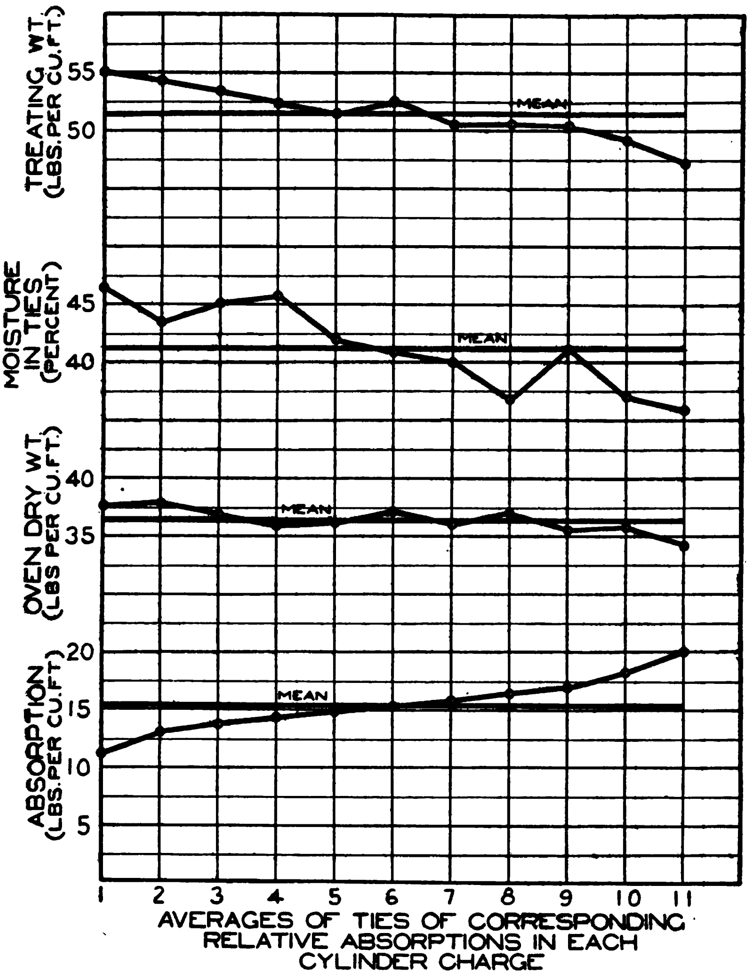


FIG. 10.—Relation of weight of wood and moisture content to absorption in red-oak ties treated by two-movement creosote-zinc chlorid process.

no particular significance in the case of hard-maple ties, except in the Card process, in which increase in absorption seems to follow decrease in moisture content. In the case of the Rueping treatment, although absorption increases slightly as oven-dry weight declines, the curves for treating weight and moisture per cent apparently have no particular significance. For the two-movement creosote-zinc-chlorid treat-

ment, the curves for treating weight, moisture per cent, and oven-dry weight actually have an upward tendency with a rise in the absorption curve. In all cases, however, the effect of moisture and oven-dry

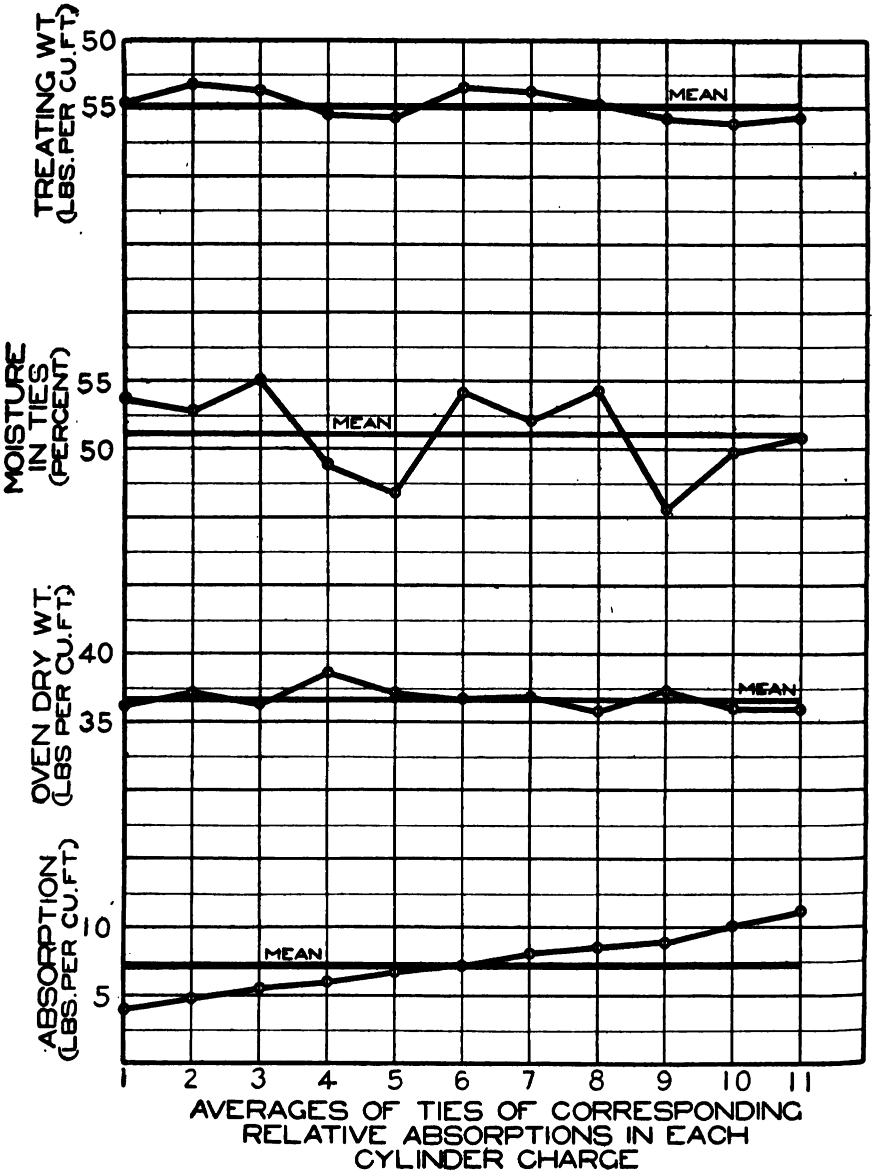


FIG. 11.—Relation of weight of wood and moisture content to absorption in red-oak ties treated with gas-house oil.

weight must be considered in conjunction with the amount of sapwood, which is discussed under the next heading. If the sapwood varies much in amount this may obscure the effect of other factors.

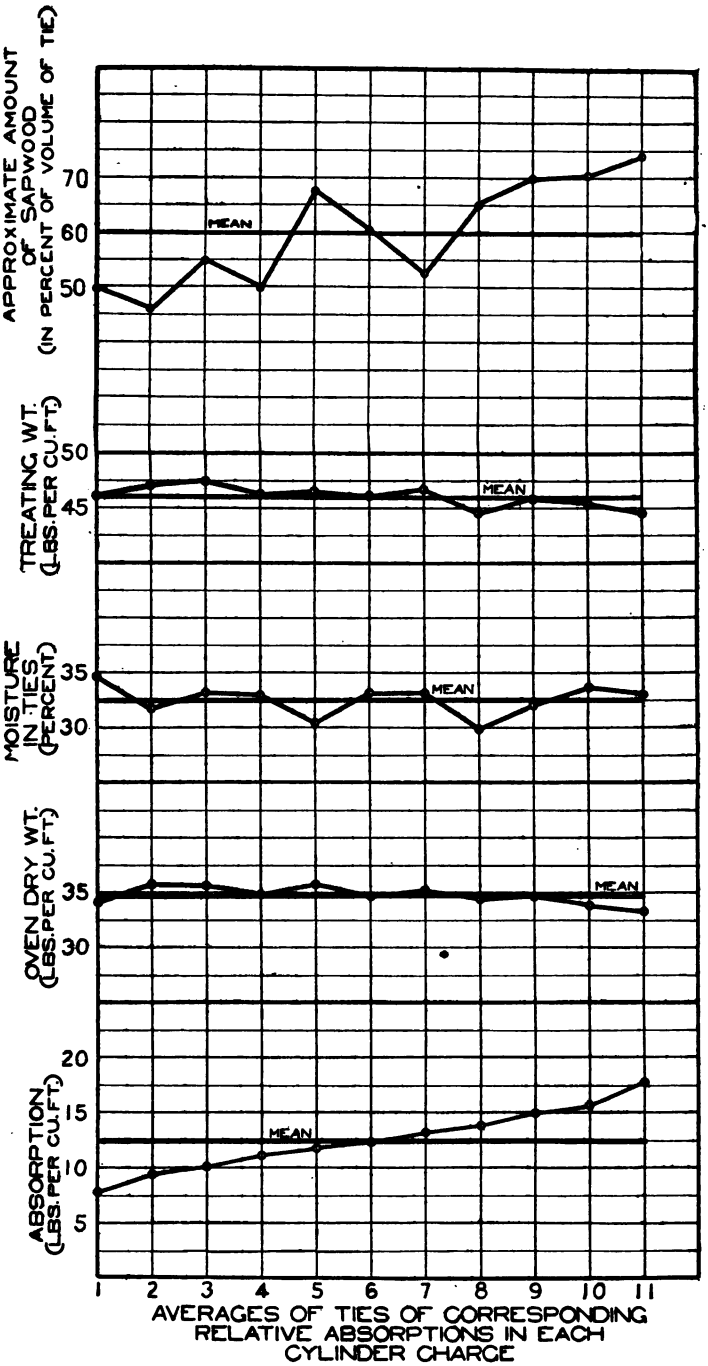


FIG. 12.—Relation of weight of wood, moisture content, and per cent of sapwood to absorption in hard-maple ties treated by full-cell creosote process.

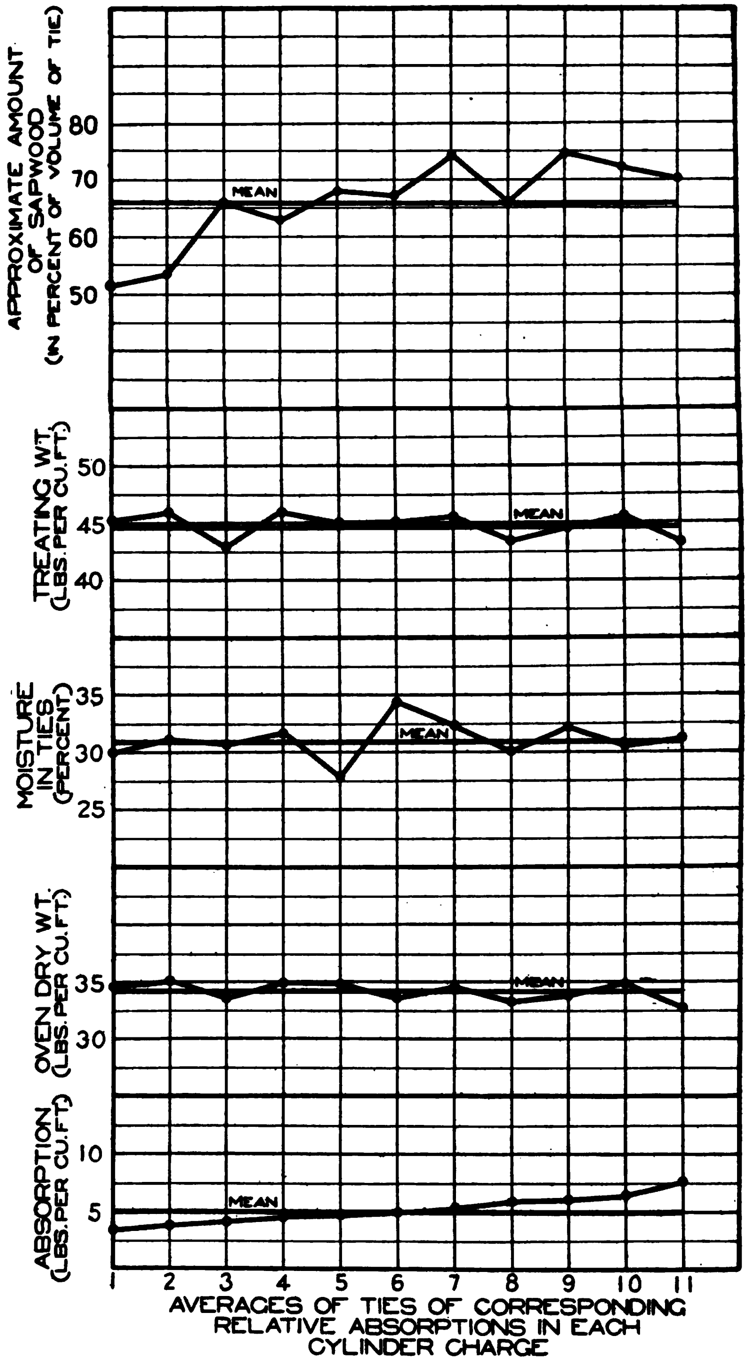
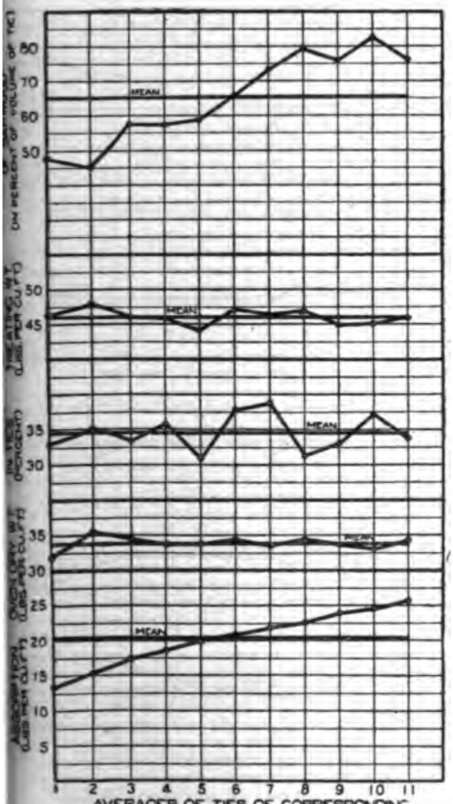


FIG. 13.—Relation of weight of wood, moisture content, and per cent of sapwood to absorption in hard-maple ties treated by Rueping process.

The effect of moisture upon absorption here noted is in accord with previous observations of the Forest Service and of those engaged in the wood-preserving industry. It might be thought that variations in the moisture content would have little influence in the case of a wood like red oak because of the comparatively large pores which are characteristic of this species. The results of this experiment, however, do not warrant such an assumption.



14.—Relation of weight of wood, moisture content, per cent of sapwood to absorption in hard-maple ties treated by Burnett process.

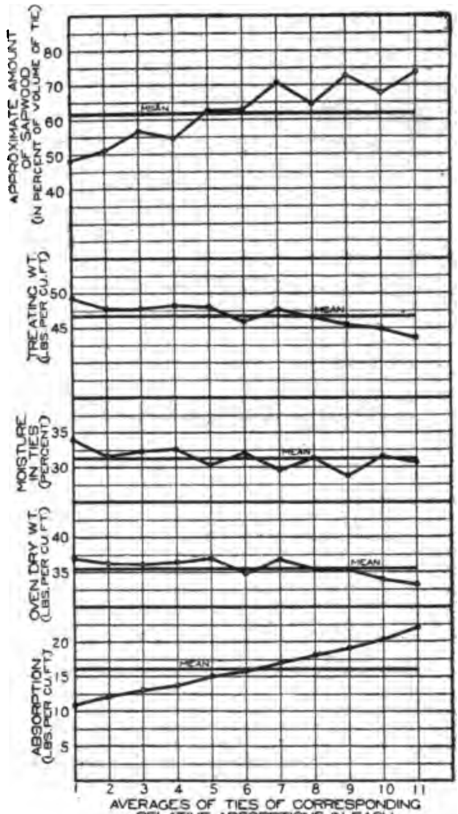


FIG. 15.—Relation of weight of wood, moisture content, and per cent of sapwood to absorption in hard-maple ties treated by Card process.

It has been shown that in the case of hard maple the preservative was absorbed principally by the sapwood. The sapwood, being on the outside of the ties, probably contained very little moisture. It is very probable, also, that the greater part of the variation in the moisture content of the hard-maple ties occurred within the inner portion of the tie, which received practically no treatment.

The effect of oven-dry weight or density of the wood on absorption is probably a matter of space—the less the density of the wood the

more free space for the entrance of the preservative. While the density of the actual wood substances appears to be practically the same in all species [1] (and therefore the relation between density and the amount of free space constant), the relations between density and absorption found in any one species would not necessarily apply among woods of different species on account of the differences in structural characteristics.

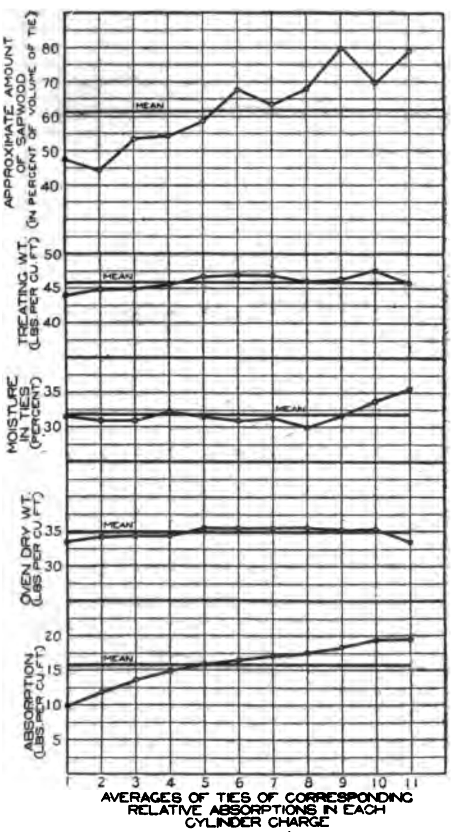


FIG. 16.—Relation of weight of wood, moisture content, and per cent of sapwood to absorption in hard-maple ties treated by two-movement creosote-zinc-chlorid process.

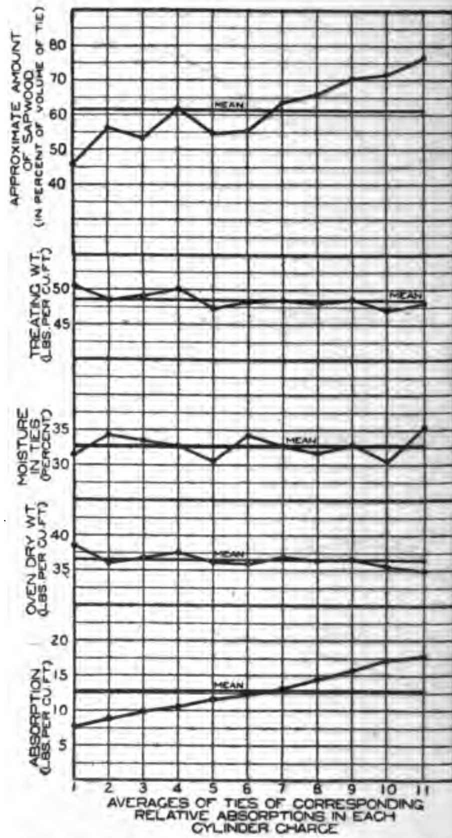


FIG. 17.—Relation of weight of wood, moisture content, and per cent of sapwood to absorption in hard-maple ties treated with gas-house oil.

RELATION BETWEEN PERCENTAGE OF SAPWOOD AND ABSORPTION.

The method of investigating the relation between percentage of sapwood and absorption of preservative was similar to that used in finding the relation between weights and absorptions, and the sapwood curves are shown in the same diagram. Attention is called to the fact that the sapwood curves are not in all cases based on the same

[1] "Uber die Porosität des Holzes," by Julius Sachs, and "Uber die Verteilung des Wassers der Luft * * * in den lebenden Baume," by Robert Hartig.

number of ties as the absorption curves, but the omissions are not sufficiently numerous to make any difference in the general relations between the two curves.[1]

In the red-oak ties the variation in the amount of sapwood was comparatively small, and no relation is found between percentage of sapwood and absorption. This would be inferred also from the appearance of the treated sections, as the preservative seemingly penetrates the heartwood as readily as the sapwood. Sapwood determinations were made on only two lots of red-oak ties; the curves are shown in figures 6 and 8.

Figures 12 to 17 show considerable variation in percentage of sapwood among the hard-maple ties, and in general the greater this percentage the greater the absorption. This relation is very marked in all of the treatments. The irregularities in the curves showing the percentage of sapwood may be due in some degree to the difficulty in discerning the line of demarcation between the heartwood and sapwood in the ties.

RELATION BETWEEN RATE OF GROWTH AND ABSORPTION.

The two ties in each cylinder charge having apparently the highest and the two having apparently the lowest average number of annual rings per inch, in the heartwood in the case of red oak and in the sapwood in the hard maple, were selected. The average number of rings per inch in each of these ties was then determined from actual count both for the heartwood and the sapwood. The count is shown by individual ties in Table 7.

Since the proportion of sapwood in the red oak was small and the preservative penetrated throughout the ties, the average number of rings per inch in the heartwood is the more important factor. On the other hand, because there was little penetration in the heartwood of the maple ties, the sapwood is the more important part to consider.

Table 3 shows that, with a few exceptions, the red-oak ties with the highest average number of annual rings per inch in the heartwood showed a higher absorption of preservative than those of lowest average number. It is also seen that the red-oak ties with the greater number of annual rings have the smaller dry weight. The finding thus agrees with the previous conclusion that ties of less density showed the greater absorptions.

---

[1] Sections from all of the ties were not available when the sapwood calculations were made.

TABLE 3.—*Relation between number of annual rings per inch and absorption of preservative.*

OAK.

Treatment.	Average[1] number of annual rings per inch in—		Average absorption of preservative per cubic foot.	Average dry weight per cubic foot.	Estimated amount of sapwood.
	Heartwood.	Sapwood.			
			Pounds.	*Pounds.*	*Per cent.*
Full-cell creosote	16.6	12.9	11.70	35.0	10.4
	9.0	8.6	10.95	36.2	12.4
Rueping	12.3	12.6	5.23	36.5	....
	8.0	8.6	4.75	37.2	....
Burnett	14.6	12.2	16.64	35.8	10.8
	7.2	7.5	16.11	37.1	15.3
Card	13.8	12.5	16.61	34.9	....
	7.6	8.7	14.21	36.9	....
Two-movement $ZnCl_2$ and creosote	12.7	11.2	15.16	35.9	....
	7.3	8.6	15.27	36.8	....
Semirefined oil, paraffin base	15.7	14.8	7.02	35.3	....
	6.7	8.1	7.71	36.5	....

MAPLE.

Treatment.	Heartwood.	Sapwood.	Average absorption of preservative per cubic foot.	Average dry weight per cubic foot.	Estimated amount of sapwood.
Full-cell creosote	23.1	23.5	11.94	34.2	62.0
	19.3	15.0	11.50	34.3	52.8
Rueping	21.9	24.0	4.30	33.5	61.5
	20.4	16.3	5.23	34.7	71.6
Burnett	22.5	24.2	18.93	34.5	61.4
	21.8	13.7	20.95	34.7	68.7
Card	24.9	28.9	14.79	35.6	58.0
	22.6	16.9	17.24	35.4	69.0
Two-movement $ZnCl_2$ and creosote	22.9	25.0	13.82	34.8	51.7
	19.7	14.4	16.35	35.0	66.0
Semirefined oil, paraffin base	24.6	25.2	11.82	36.2	62.6
	20.8	17.7	13.41	36.1	68.4

[1] This refers to the averages of the two ties in each cylinder charge having the lowest number of annual rings per inch and the two ties having the highest number of annual rings per inch.

NOTE.—Data in all columns refer to the same ties.

In the case of maple the ties with the greater number of rings per inch (excepting those treated by the full-cell creosote process) showed the smaller absorptions, the rings in the sapwood being considered. As in the oak, the ties of slower growth (more rings to the inch) had in general the smaller dry weight per cubic foot, although the difference was very small. However, ties of more rapid growth had the greater amount of sapwood, which accounts for their greater absorption. In the case of both the red oak and maple the effect of number of rings per inch was comparatively small.

LOSS OF WEIGHT AFTER TREATMENT.

Although the treatments extended over a period from November 1 to about May 1, there was little chance for loss of weight by seasoning during the winter months because of the freezing weather. The final weights were taken the latter part of June, and for practical purposes the effective seasoning period of the ties was from about two to three months in all cases. A summary of the weights by

cylinder charges is given in Table 15 of the appendix, and the averages for the ties in each treatment are given in Table 4.[1]

TABLE 4.—*Seasoning of the ties after treatment (average values for each process).*

Treatment.	Species.	Approximate date of treatment.[1]	Date of reweighing.	Average time seasoned.	Average moisture.	Average weight of ties directly after treatment.	Average weight of ties before laying in track.	Average loss in weight per cubic foot.	Average absorption per cubic foot.	Average loss in weight after treatment.
		1910.	1911.	*Days.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Per ct.*[2]
Full-cell creosote	Red oak.	Nov. 1	June 20	200	45.0	181.9	175.1	2.08	10.95	19.0
Do	Maple	1911. Mar. 4	June 22	105	32.4	183.7	178.6	1.63	12.26	13.4
Rueping	Red oak.	1910. Nov. 10	June 20	204	45.7	155.0	147.6	2.85	5.39	52.7
Do	Maple	1911. Mar. 10	June 22	104	31.1	152.8	149.3	1.13	5.03	22.5
Burnett	Red oak.	Jan. 18	June 21	154	44.0	192.3	164.0	10.33	16.81	61.4
Do	Maple	Feb. 6	do	135	35.2	206.1	157.2	15.69	20.22	77.7
Card	Red oak.	Apr. 12	June 26	74.5	40.0	186.5	165.0	7.54	15.26	49.5
Do	Maple	Apr. 22	do	65	31.3	193.8	170.3	7.59	16.12	47.0
Two-movement $ZnCl_2$ and creosote.	Red oak.	Mar. 24	June 23	92	40.9	193.0	168.9	8.35	15.29	54.7
Do	Maple	Apr. 1	June 24	85	31.4	189.0	160.1	9.35	15.75	59.4
Semirefined oil, paraffin base.	Red oak.	Apr. 29	June 23	53	50.7	173.2	166.6	2.40	7.37	32.6
Do	Maple	May 3	June 24	52	32.7	186.9	183.5	1.10	12.66	8.7

[1] Date given is intermediate between dates of first and last treatments. [2] Based on the absorption.

Table 4 shows that in every treatment using oils alone there was a considerably greater loss in weight for the red-oak than for the hard-maple ties, while the reverse was the case with the treatments in which zinc-chlorid solutions were used either alone or in the two-movement process. The difference in behavior is doubtless largely an effect of differences in the size and arrangement of the elements of the two woods. It is probably not due to a difference in their moisture content, since in every treatment the red oak had a higher moisture content than the hard maple. The following seems to be a logical explanation for the phenomena: In the red oak the liquid, whether an oil or a solution, penetrated to the center of the ties. In the hard maple, on the other hand, the penetration, while complete in the sapwood, was erratic, but in no case complete in the heartwood. Hence it is evident that the liquid was nearer the surface of the tie in the maple than in the oak. As the cell walls are more permeable to water than to oils, this fact would have more influence on the evaporation in the case of the ties treated with water solutions than in the case of those treated with oils. In the latter case the relative size of the pores of the two species was probably the controlling factor. Since the vessels were very much smaller in the maple than in the red oak, the latter species would therefore be expected to lose more weight during seasoning after having been treated with an oil.

How great a proportion of the loss of the oils was due to dripping is unknown. The red-oak ties did not appear to be quite so dry after

[1] The average absorptions shown in Tables 4 and 15 vary slightly from the averages shown in Tables 1 and 13 for the reason that the latter are based on full cylinder charges, while the ties cut up for penetration determinations are omitted from Tables 4 and 15.

treatment as the hard maple. Especially was this the case with the Rueping-treated oak ties, which appeared relatively wet for many hours after treatment.[1] This may explain in some degree their comparatively great loss in weight, which was greater than that of any other red-oak ties treated with an oil only. The fact that the Rueping is an empty-cell treatment, in which the pores of the wood are presumably not fully plugged up with oil, may have permitted greater volatilization from the interior of the red oak. In case of the maple ties, however, there was a greater actual loss in weight in those treated by the full-cell creosote process than in those treated by the Rueping process.

It may be that the vessels in the maple are sufficiently small to be largely plugged up by an oil, thus preventing any great amount of volatilization from the interior of the tie, even when treated by an empty-cell process.

APPLICATION OF THE RESULTS TO OTHER SPECIES OF WOOD.

It would seem that the results of the experiments described in this bulletin might be logically applied to other species of hardwoods having a structure similar to that of red oak and of hard maple. It is essential to bear in mind, however, that the vessels in many species of hardwoods, such as the white oaks and chestnuts, are obstructed by growths of tyloses, which, to a greater or less extent, affect the penetration and absorption of preservatives. Also many species of hardwoods contain gums and other materials which may have a similar effect, especially in the heartwood. In the case of conifers the structure of the wood is so different from that of hardwoods that no attempt should be made to apply to them the results of these experiments.

CONCLUSIONS.

Following is a summary of the conclusions drawn from the experiments discussed in this bulletin:

(1) Under the same conditions of treatment a given absorption per cubic foot of wood was obtained in a shorter time in hard-maple than in red-oak ties.

(2) For a given treatment individual ties of hard maple in the same cylinder charge showed a greater variation from the average absorption than did red-oak ties.

(3) There was less likelihood of excessively low than of excessively high absorption among the individual ties in a given cylinder charge of red oak.

(4) There was no appreciable difference in the penetration secured in red-oak ties treated by the full-cell creosote process, using 12 pounds

[1] The most noticeable amount of drip occurred after treatments of red-oak ties by the Rueping process. It has been suggested that if the final vacuum had been held for a longer period the dripping of these ties might have been reduced.

per cubic foot of wood, and in those treated by the Rueping process, using 5 pounds of creosote per cubic foot of wood. In the maple ties the difference was very small.

(5) Both red-oak and hard-maple ties showed a greater penetration of creosote when treated by the Card than by the two-movement creosote-zinc-chlorid process.[1]

(6) The penetration of preservative in hard-maple ties was largely in the sapwood and in the seasoning checks; it was very erratic in the heartwood.

(7) In the Burnett and Card treatments the average absorption of dry zinc chlorid per cubic foot of wood at a point 2 feet from the ends of 8-foot red-oak ties, determined by chemical analyses, averaged, respectively, from 13.5 to 15.4 per cent less than the average calculated absorption per cubic foot for the entire ties. For the maple ties the difference was 26.6, 25.6, and 25 per cent in the Burnett, Card, and two-movement creosote-zinc-chlorid treatments, respectively.

(8) The absorption of preservative per cubic foot of wood in red-oak ties was in inverse proportion to the moisture content and oven-dry weight.

(9) The absorption of preservative per cubic foot of wood in red-oak ties appeared to bear no relation to the proportion of sapwood in the ties.

(10) The absorption of preservative per cubic foot of wood in hard-maple ties increased as the proportion of sapwood in the ties increased.

(11) The absorption of preservative per cubic foot of wood in red-oak ties increased as the average number of annual rings per inch increased, but the variation was slight.

(12) The absorption of preservative per cubic foot of wood in hard-maple ties having nearly equal proportions of sapwood increased as the oven-dry weight per cubic foot decreased. The oven-dry weight per cubic foot of red-oak ties increased as the average number of annual rings per inch decreased.

(13) The rate of loss in weight after treatment was greater for red-oak than for hard-maple ties treated in a similar manner with creosote only or with the gas-house oil used in these experiments.

(14) The rate of loss in weight after treatment was greater for hard-maple than for red-oak ties treated in a similar manner with aqueous solutions of zinc chlorid, whether used alone or in combination with creosote in the two-movement process.

(15) It is believed that the results of these experiments on red-oak and hard-maple ties may, in the absence of any data to the contrary, be logically applied to other hardwoods in proportion to their similarity in structure to red oak and hard maple.

[1] This, of course, does not refer to the Allardyce process, but only to the two-movement process as operated in these experiments.

PART II.—THE TEST TRACK.

LOCATION AND PLAN.

In selecting a location for the test track the aim was to secure normal conditions of site and traffic. The location is in the northern division of the Chicago, Milwaukee & St. Paul Railway, just east of Hartford, Wis. The road is single track and carries a fairly heavy traffic in both directions. The track at the point where the ties are laid is gravel ballasted, well drained, straight, and practically level. (Pl. IX.) Nearly all of the ties treated at the Forest Products Laboratory are placed on a fill; a few of the treated ties which were included in the test come in a cut (for about 150 feet at the western end of the track). Plate IX shows the general character of the track and right of way at the site of the test. A list of the ties included is given in Table 5.

TABLE 5.—*List of ties laid in the experimental track.*

Tie numbers.	Species.	Treatment.	
		Process.	Preservative.
1 to 100	Red oak	Rueping	Coal-tar creosote.
[1]101 to 200	.....do	Full-cell	Do.
201 to 300	.....do	Burnett	Zinc chlorid.
301 to 400	Hard maple	.....do	Do.
401 to 500	.....do	Rueping	Coal-tar creosote.
501 to 600	.....do	Full-cell	Do.
601 to 700	Red oak	.....do	Gas-house oil.
701 to 800	.....do	Untreated	
801 to 900	.....do	Two-movement	Creosote and zinc chlorid.
901 to 925	Spruce	Kyan	Mercuric chlorid.
[2]926 to 947	Chestnut	Burnett	Zinc chlorid.
1001 to 1100	Hard maple	Two-movement	Creosote and zinc chlorid.
1101 to 1200	.....do	Card	Do.
1201 to 1300	Red oak	.....do	Do.
1301 to 1400	.....do	Burnett	Zinc chlorid.
1401 to 1500	Hard maple	Full-cell	Gas-house oil.
1501 to 1600	.....do	Untreated	
[3]2001 to 2154	Red oak	Burnett	Zinc chlorid.

[1] Two duplicate numbers. [2] One number missing. [3] Eight duplicate numbers.

Screw spikes with flat tie-plates were used on 50 per cent of the ties treated at the Forest Products Laboratory and on the accompanying untreated ties; the remaining 50 per cent, unprotected by tie-plates, were fastened by ordinary cut spikes. As an extension to the original experiment 262 red-oak and 21 chestnut ties treated at a commercial plant by the Burnett process were added.[1] Some of each species of these ties were laid with screw spikes and flat steel tie-plates, and others with ordinary cut spikes and malleable-iron ribbed tie-plates. Also, 25 spruce ties treated by the Kyanizing process were included.[2] Of these, 13 were put in with screw spikes and flat steel tie-plates, and the remainder with ordinary cut spikes,

[1] These ties were treated with 0.5 pound of dry zinc chlorid per cubic foot of wood, injected in a 4 per cent aqueous solution. They were furnished from regular stock of the Chicago, Milwaukee & St. Paul Railway.

[2] The Kyanized ties were contributed by the Berlin Mills Co., Manchester, N. H.

FIG. 1.—TIES AND RAILS READY TO BE PLACED IN THE TRACK.

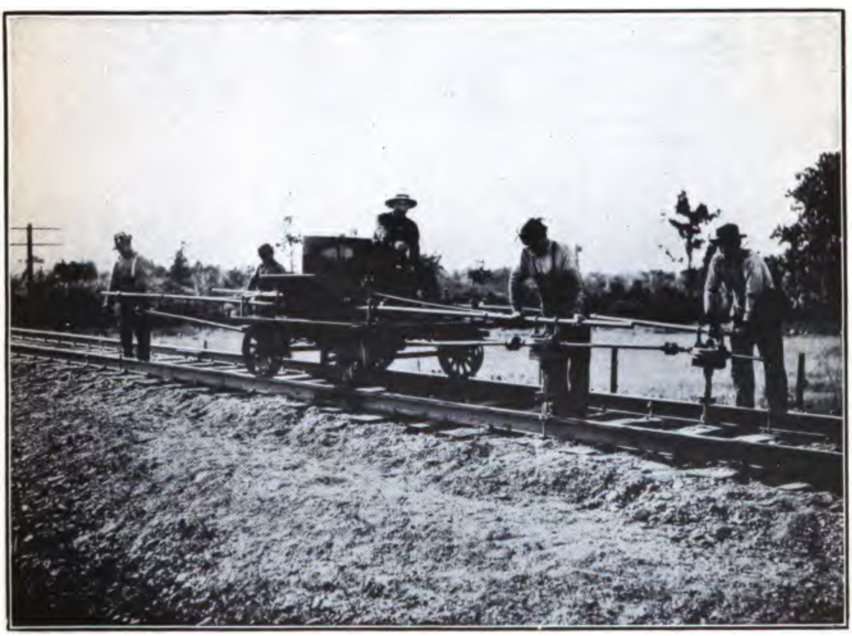


FIG. 2.—BORING TIES AND DRIVING SCREW SPIKES IN THE TIES IN THE TEST TRACK.

and without tie-plates. The plan of the track is shown as figure 18 in the accompanying sheet (folder). To avoid disturbing the track in the future new rails were laid at the time the ties were placed. New fastenings also were used throughout.

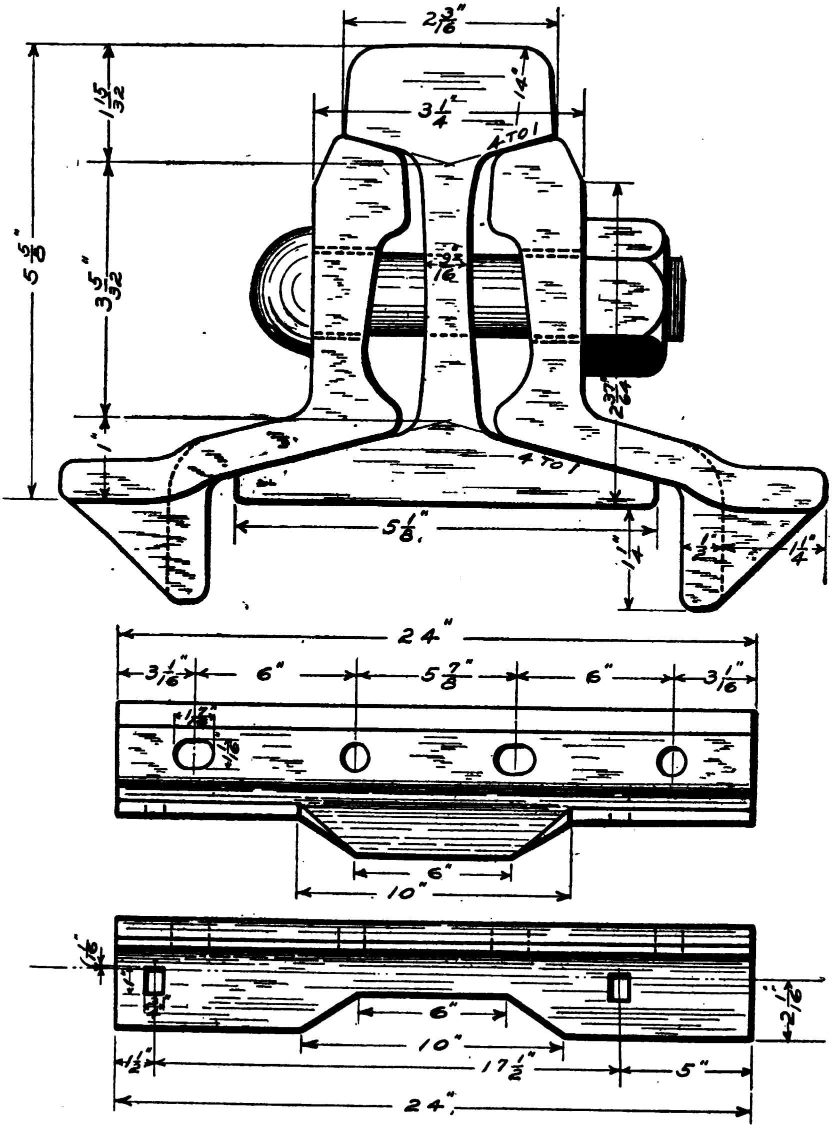


FIG. 19.—Details of rail joint and rail section used in test track.

RAIL, PLATES, AND FASTENINGS.

American Railway Association type A ferrotitanium rail, weighing 90 pounds to the yard, was used. Details of the rail section and rail joint are shown in figure 19.

The flat-steel plates used with the screw spikes had a boss for supporting the head of the spike. The tie-plates are shown in figures 20 and 21, and the screw spike in figure 22.

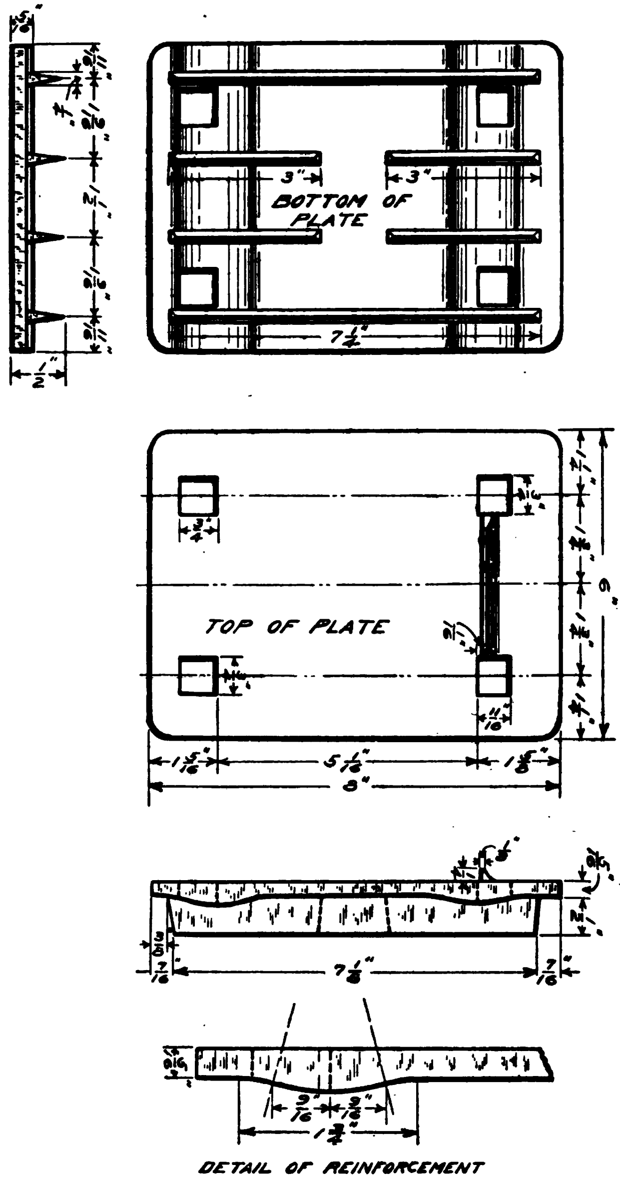


FIG. 20.—Details of malleable-iron ribbed tie-plate used with cut spikes on some ties in test track.

LAYING THE TRACK.

The track was laid in August, 1911. The old rails and ties were removed, and new rails and the experimental ties, 22 to each 33-foot rail length, were placed in the track. The rails were laid with

joints staggered or broken. The usual methods of track construction were followed in most respects. In driving the screw spikes it was necessary to bring the rails to the proper gauge with the tie-plates in position under them, and the ties were then bored by using the plates as templates.[1] Both the boring and driving were done by means of a power track car especially constructed for screw-spike driving.[2] (Plate IX.) Spike holes in all the treated ties were filled

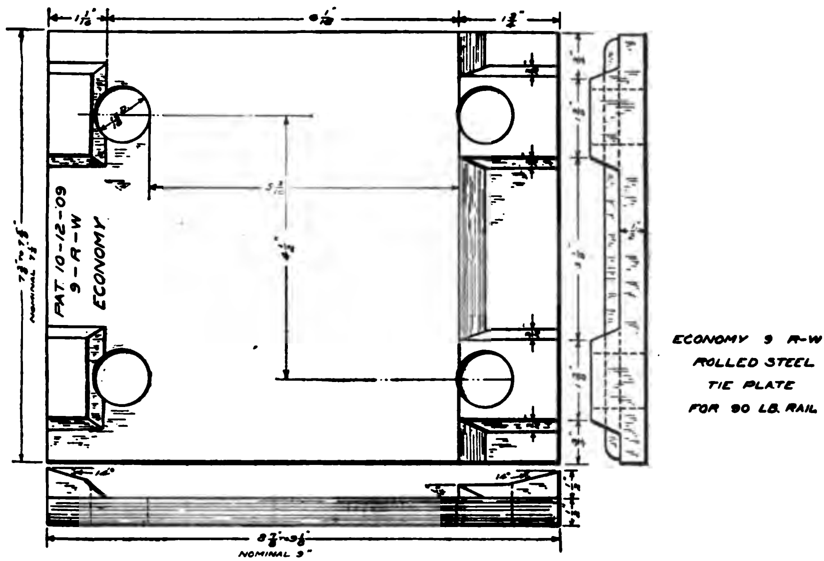


FIG. 21.—Details of flat steel tie-plate used with screw spikes.

with creosote in order to avoid any bad effects which might have resulted from not boring the holes previous to treatment.

After the track had been laid a thorough inspection was made in order to record exceptions from the proper numerical order of the ties and to mark all tie-plates and spikes improperly placed. Ties on which the tie-plates or rails did not fit properly were adzed sufficiently to secure a good bearing, and improperly driven spikes were reset. Creosote was poured on all adzed surfaces of treated ties. From the results of this inspection the map shown in figure 18 was prepared.

A record was made also of any special points in connection with individual ties, and these are given in Table 6.

[1] The ties could not be bored before treatment, due to the fact that at that time the weight of rail and style of tie-plate had not been determined.

[2] This car was loaned for the occasion by the Spencer-Otis Co., of Chicago, Ill.

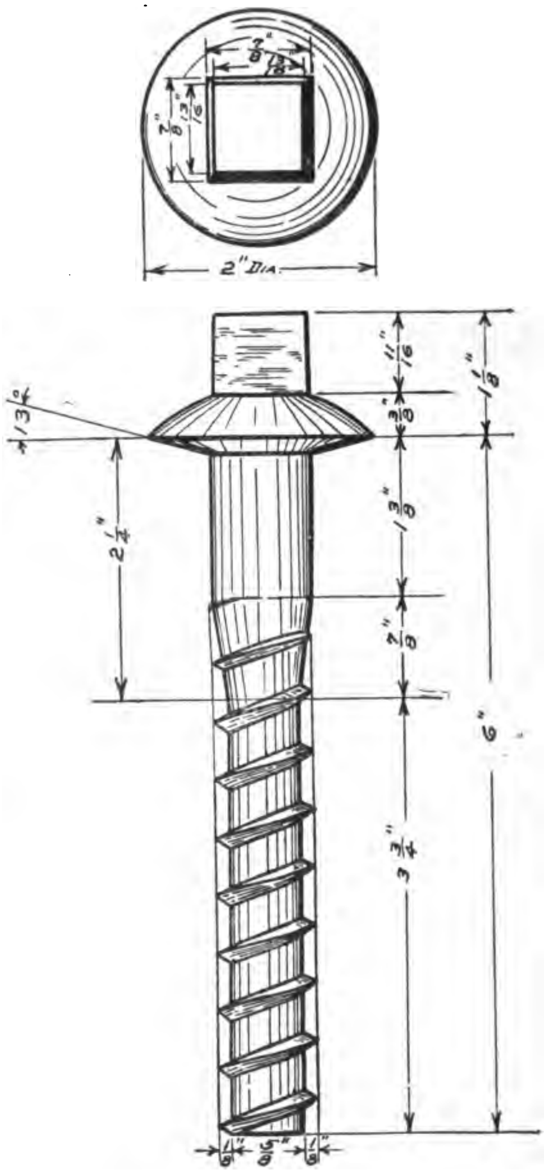


FIG. 22.—Details of screw spike.

TABLE 6.—*Remarks on certain of the ties in the test track.*

Tie No.	Remarks.	Tie No.	Remarks.
7	North end adzed to fit tie plate.	631	Both ends adzed to fit tie plate.
16	South end adzed to fit tie plate.	632	South end adzed to fit tie plate.
24	Both ends adzed to fit tie plate.	837	Do.
50	South end adzed to fit tie plate.	838	Both ends adzed to fit tie plate.
114	North end adzed to fit rail.	854	South end adzed to fit rail.
130	Do.	866	South end adzed to fit rail joint.
144	North end adzed to fit tie plate.	1251	South end adzed to fit tie plate.
151	Both ends adzed to fit tie plate.	1279	Do.
152	North end adzed to fit tie plate.	1281	Both ends adzed to fit tie plate.
154	Do.	1284	Do.
155	Both ends adzed to fit tie plate and rail joint.	1294	South end adzed to fit tie plate.
		2108	North end cut spikes.
172 to 182, inclusive.	Covered with planks and ballast for farm crossing.	2109	Do.
		2110	Do.
182	North end adzed to fit tie plate.	2111	Do.
188	Do.	2112	Do.
192	Do.	2113	Do.
207	Both ends adzed to fit rail.	2114	Do.
223	South end adzed to fit rail.	2118	Both ends cut spikes.
252	Both ends adzed to fit rail.	2119	Do.
261	Do.	2120	Do.
262	South end adzed to fit tie plate.	2122	Do.
275	North end adzed to fit rail joint.	2123	Do.
400	South end adzed to fit tie plate.	2124	South end cut spikes.
408	South end, 3 screw spikes in plate.	2127	Both ends cut spikes.
		2142	Tie about 4 inches too long.
479	Both ends adzed to fit tie plate.	2144	Tie about 9 inches too short.
617	South end adzed to fit tie plate.	2150	South end cut spikes.
628	North end adzed to fit tie plate.	2154	Do.
630	Do.		

RECORDS.

The ties were marked for identification by numbered galvanized nails driven into each tie at a point approximately 3 feet from the end. This was done before the ties were treated. At the time of placement each lot was assorted and arranged in serial order, or practically so. The different lots, however, do not in all cases follow each other in such order. (See fig. 18.) A detailed record of the characteristics and treatment of each tie is given in Table 7.

The test track will be inspected at least once each year by representatives of the Chicago, Milwaukee & St. Paul Railway Co. and the Forest Service, and a report will be prepared after each inspection giving the condition of the ties at that time. These inspections will pay special attention to the extent of decay and rail wear of the ties and to the holding power of the spikes.[1] If possible, the tonnage conditions will also be recorded. When replacements are made by the railroad company, the removed ties will be held for an inspection by representatives of the Forest Service.

[1] It was noticed that in "throwing" the rail while the track was being aligned, the cut spikes were in some cases slightly bent, while the screw spikes, so far as could be ascertained, remained firmly in place. The slight bending of the cut spikes, however, was no more marked than would be the case in ordinary track construction. The point is mentioned simply to indicate the greater stability of the screw-spike fastening used in this track over the ordinary cut spike without tie plates.

TABLE 7.—*General records on the individual ties.*

RUEPING—RED OAK.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Average number of annual rings per inch in— Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Weight of tie. Directly after treatment.	Weight of tie. Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1	26	40.45	2.36	....	....	....	40.4	134	142	....	3.39
*1	8	38.49	2.38	10.0	10.0	....	48.5	136	147	....	4.60
2	8	37.19	2.60	9.5	5.4	....	49.0	144	157	148	5.00
3	8	36.93	2.93	....	....	....	51.5	164	180	172	5.46
4	8	38.50	2.55	8.6	6.4	....	53.8	151	161	157	4.24
5	8	40.30	2.65	....	....	....	44.2	154	169	161	5.70
6	8	40.71	2.84	....	....	....	38.4	160	172	162	4.26
7	8	37.19	2.75	7.5	10.1	....	40.8	144	155	....	4.00
8	8	....	....	....	....	....	....	178	191	182	....
9	8	37.08	2.82	....	....	....	51.2	158	182	161	8.50
10	8	38.80	2.86	....	....	....	46.0	162	172	165	3.50
11	9	29.69	3.62	17.1	15.8	....	49.4	160	178	....	5.00
*9	9	34.38	2.28	8.3	9.0	....	53.0	120	130	....	4.40
12	9	....	2.04	....	....	....	....	110	118	115	3.90
13	9	35.49	2.47	....	....	....	49.5	131	142	....	4.50
14	9	35.15	2.11	....	....	....	47.0	109	120	115	5.20
15	9	40.76	1.96	....	....	....	32.6	106	114	109	4.10
16	9	39.30	2.62	....	....	....	40.9	145	158	150	5.00
17	9	38.20	2.19	7.7	12.1	....	42.2	119	128	122	4.10
18	9	36.89	2.06	....	....	....	37.0	104	112	108	3.90
19	9	34.32	2.65	8.4	15.0	....	58.2	144	154	152	3.80
20	9	33.95	2.40	....	....	....	62.0	132	144	138	5.00
21	19	36.73	2.21	....	....	....	42.9	116	125	120	4.07
*30	19	37.55	2.28	....	....	....	44.8	124	136	....	5.26
22	19	36.29	2.60	....	....	....	46.2	138	153	146	5.77
23	19	36.81	1.99	14.4	19.0	....	51.5	111	121	115	5.02
24	19	36.72	2.43	9.4	7.3	....	44.6	129	138	132	3.70
25	19	37.12	2.18	9.0	6.0	....	43.2	116	129	125	5.96
26	19	37.11	2.18	....	....	....	48.3	120	130	124	4.58
27	19	37.03	2.02	....	....	....	50.0	112	125	120	6.44
28	19	37.45	2.26	....	....	....	44.1	122	132	127	4.43
29	19	38.25	2.13	....	....	....	44.7	118	131	126	6.10
30	19	36.45	3.01	10.5	11.6	....	56.8	172	188	186	5.32
31	21	37.04	3.15	....	....	....	50.8	176	193	183	5.40
*38	21	35.79	2.38	10.0	11.2	....	55.2	132	142	....	4.20
32	21	37.19	2.87	....	....	....	51.0	161	171	164	3.50
33	21	38.02	2.70	....	....	....	49.0	153	164	155	4.10
34	21	37.00	3.28	....	....	....	43.3	174	196	190	6.70
35	21	36.06	2.81	8.8	10.6	....	50.1	152	167	157	5.30
36	21	35.90	2.72	10.0	10.0	....	51.5	148	162	154	5.10
37	21	36.20	2.57	....	....	....	46.2	136	153	145	6.56
38	21	36.60	3.03	....	....	....	58.7	176	185	171	3.00
39	21	38.58	3.11	8.0	10.2	....	51.7	182	190	180	2.60
40	21	38.10	2.74	....	....	....	43.6	150	161	152	4.00
41	22	28.12	2.87	7.2	10.0	....	58.6	128	150	144	7.67
*47	22	35.99	2.36	....	....	....	36.7	116	130	....	5.94
42	22	39.55	2.21	8.8	7.7	....	32.5	116	126	121	4.39
43	22	38.60	2.92	8.4	6.0	....	35.8	153	168	159	5.14
44	22	36.39	2.33	....	....	....	30.9	111	130	123	8.16
45	22	38.70	2.89	....	....	....	39.5	156	166	162	3.46
46	22	38.90	2.57	....	....	....	36.0	136	154	146	7.00
47	22	38.77	3.43	....	....	....	29.3	172	198	189	7.58
48	22	38.09	2.50	....	....	....	43.8	137	146	141	3.60
49	22	37.62	2.60	10.0	11.6	....	35.9	133	150	143	6.54
50	22	38.41	2.64	....	....	....	36.1	138	152	148	5.30
51	23	38.22	2.13	....	....	....	32.7	108	116	113	3.76
*58	23	37.60	2.31	....	....	....	39.4	121	134	....	5.63
52	23	38.38	2.48	8.3	7.5	....	42.8	136	144	137	3.23
53	23	37.35	2.11	....	....	....	32.0	104	118	110	6.64
54	23	37.50	1.96	....	....	....	49.6	110	116	110	3.06
55	23	36.23	2.33	....	....	....	37.5	116	126	122	4.29
56	23	35.85	2.33	9.5	8.7	....	43.7	120	130	....	4.29
57	23	38.23	2.07	11.1	14.1	....	33.8	106	122	114	7.74
58	23	37.99	2.26	....	....	....	37.5	118	132	122	6.20
59	23	36.74	2.21	6.0	6.9	....	49.1	121	128	124	3.17
60	23	38.58	1.94	....	....	....	39.1	104	114	109	5.16
61	24	38.45	3.64	11.3	8.7	....	50.0	210	226	215	4.40
*67	24	36.48	3.18	....	....	....	58.6	184	202	....	5.66

*Sawed for penetration determinations, and therefore not laid in track.

TABLE 7.—*General records on the individual ties*—Continued.

RUEPING—RED OAK—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
62	24	37.22	3.20	......	......	......	56.2	186	214	194	8.75
63	24	38.49	3.28	......	......	......	50.6	190	196	......	1.80
64	24	35.80	2.82	14.5	17.0	......	56.4	158	174	166	5.68
65	24	37.31	3.74	......	......	......	57.6	220	242	229	6.30
66	24	36.59	3.15	......	......	......	56.4	180	195	187	4.77
67	24	34.19	2.19	......	......	......	60.4	120	133	127	5.94
68	24	37.60	3.20	14.6	14.1	......	51.2	182	197	188	4.69
69	24	38.10	3.50	7.3	14.2	......	49.9	200	222	211	6.28
70	24	36.40	3.18	......	......	......	50.3	174	196	189	6.92
71	25	41.19	2.58	8.8	7.7	......	50.6	160	164	155	1.55
*76	25	42.45	2.55	......	......	......	33.0	144	158	......	5.50
72	25	40.42	2.09	......	......	......	30.2	110	131	123	10.0
73	25	44.84	2.14	......	......	......	25.0	120	135	130	7.00
74	25	40.32	2.11	......	......	......	38.6	118	132	123	6.64
75	25	40.09	2.48	......	......	......	32.8	132	144	140	4.84
76	25	40.67	2.96	......	......	......	36.3	164	181	177	5.75
77	25	42.10	2.47	9.0	8.0	......	42.4	148	162	152	5.67
78	25	41.18	2.13	5.0	7.3	......	30.0	114	123	118	4.23
79	25	39.60	2.28	......	......	......	41.8	128	139	131	4.83
80	25	40.02	2.24	9.5	15.8	......	45.0	130	143	133	5.80
81	26	36.12	3.04	7.7	11.0	......	30.3	143	172	170	9.55
87	26	35.41	2.67	......	......	......	60.7	152	167	......	5.63
82	26	41.30	2.41	......	......	......	41.6	141	154	146	5.40
83	26	37.96	2.52	8.7	6.5	......	38.0	132	146	140	5.56
84	26	38.30	2.72	......	......	......	42.2	148	160	151	4.42
85	26	34.75	......	......	......	......	......	162	182	172	......
86	26	32.04	3.11	......	......	......	50.6	150	176	170	5.15
*87	26	33.70	2.64	......	......	......	57.4	140	158	......	6.82
88	26	38.30	2.79	8.8	8.1	......	46.9	157	172	162	5.38
89	26	37.32	3.06	......	......	......	48.9	170	189	177	6.21
90	26	33.61	2.35	16.2	16.0	......	58.2	125	136	129	4.68
91	27	34.90	2.26	18.3	20.0	......	51.0	119	137	132	7.96
*98	27	36.22	2.99	......	......	......	48.6	161	180	......	6.35
92	27	37.25	2.50	......	......	......	49.2	139	153	148	5.60
93	27	38.53	2.64	......	......	......	45.5	148	161	153	4.93
94	27	36.89	2.47	7.5	8.3	......	51.5	138	151	145	5.26
95	27	37.10	2.26	......	......	......	50.4	126	140	130	6.20
96	27	36.22	2.01	......	......	......	44.2	105	124	114	9.45
97	27	35.45	2.36	......	......	......	54.1	129	148	137	8.05
98	27	35.64	2.26	6.5	6.5	......	51.4	122	136	126	6.20
99	27	35.75	2.40	17.8	13.3	......	50.4	129	142	137	5.41
100	27	34.90	3.13	......	......	......	59.3	174	192	183	5.75

FULL-CELL CREOSOTE—RED OAK.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot.
101	[1] 16	37.68	2.65	10.0	3.3	16.0	38.2	[2] 138	[3] 174	169	13.6
102	[1] 16	34.38	2.98	......	......	6.3	54.1	[2] 158	[3] 190	185	10.8
103	[1] 16	38.29	2.81	10.0	9.7	7.0	41.2	[2] 152	[3] 183	180	11.0
104	[1] 16	37.04	2.88	......	......	9.1	50.0	[2] 160	[3] 191	185	10.8
105	[1] 16	38.04	2.91	......	......	26.8	48.1	[2] 164	[3] 194	190	10.3
106	[1] 16	35.01	2.55	......	......	7.3	50.1	[2] 134	[3] 157	152	9.0
107	[1] 16	32.55	3.04	23.0	19.9	10.6	59.6	[2] 158	[3] 197	193	12.8
108	[1] 16	30.28	2.92	19.9	11.0	6.4	47.0	[2] 130	[3] 184	180	18.5
109	[1] 16	33.95	2.65	......	......	12.3	60.0	[2] 144	[3] 176	160	12.1
109-1	34	34.60	2.64	......	......	12.8	42.3	130	163	......	12.5
110	[1] 16	35.75	2.43	......	......	10.5	46.1	[2] 127	[3] 148	137	8.6
111	3	35.59	3.11	8.7	9.0	10.5	38.3	153	184	......	10.0
112	3	40.08	2.38	......	......	12.2	35.2	129	152	147	9.7
113	3	40.35	2.55	......	......	8.5	37.9	144	172	166	11.0
114	3	35.86	3.23	19.0	7.3	20.4	41.6	164	203	199	12.1
115	3	37.32	2.93	......	......	7.2	51.7	166	197	190	10.6
116	3	32.71	2.41	......	......	15.6	59.8	126	153	......	11.2
116-1	34	39.71	2.04	......	......	4.4	37.0	111	128	125	8.3

* Sawed for penetration determinations, and therefore not laid in track.
[1] Re-treatment. [2] Weight before first treatment. [3] Weight after final treatment.

TABLE 7.—*General records on the individual ties*—Continued.

FULL-CELL CREOSOTE—RED OAK—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
117	3	38.88	2.91	9.3	5.0	7.3	43.2	162	191	196	10.0
118	3	39.85(?)	2.79(?)	7.5	10.0	12.5	40.6(?)	156	188	183	13.9
119	3	40.71	3.01	....	....	23.3	27.4	156	196	191	13.3
120	3	38.80	2.96	....	....	22.7	49.7	172	202	195	7.7
121	34	36.91	2.30	6.9	7.2	12.9	47.3	125	148	140	10.0
*121	[1]20	37.86	2.80	8.9	6.6	11.3	52.8	[2]162	[3]194	....	11.4
122	[1]20	38.28	2.98	18.2	16.6	10.9	43.7	[2]164	[3]193	191	7.1
123	[1]20	31.25	3.24	....	....	6.5	54.0	[2]156	[3]199	193	13.3
124	[1]20	36.21	2.47	....	....	12.8	36.5	[2]122	[3]158	157	14.6
125	[1]20	40.00	3.18	....	....	....	44.7	[2]184	[3]216	210	10.1
126	[1]20	43.05	3.47	....	....	14.8	32.5	[2]198	[3]234	225	10.4
127	[1]20	39.71	2.64	8.4	6.3	13.1	37.4	[2]144	[3]172	165	10.6
128	[1]20	38.33	2.50	....	....	23.5	48.3	[2]142	[3]168	....	10.4
129	[1]20	39.71	2.36	21.4	16.0	12.5	36.6	[2]128	[3]154	....	11.0
130	[1]20	35.18	2.43	....	....	14.3	35.8	[2]116	[3]156	155	14.6
131	[1]15	35.18	2.74	....	....	....	51.5	[2]146	[3]185	178	14.2
*140	[1]15	38.58	2.58	....	....	31.2	48.7	[2]148	[3]173	....	9.7
132	[1]15	37.10	3.00	....	....	11.5	42.0	[2]158	[3]199	193	13.7
133	[1]15	38.39	2.36	10.0	7.7	10.3	34.7	[2]122	[3]140	136	6.8
134	[1]15	35.37	2.84	....	....	12.7	53.4	[2]154	[3]180	173	9.2
135	[1]15	39.09	3.13	11.7	5.4	11.1	40.6	[2]172	[3]202	196	9.6
136	[1]15	40.80	2.72	29.7	6.9	11.4	31.6	[2]146	[3]172	166	9.6
137	[1]15	34.71	2.81	....	....	13.2	53.7	[2]150	[3]184	177	12.1
138	[1]15	32.89	2.38	11.4	13.0	17.6	53.3	[2]120	[3]142	137	9.2
139	[1]15	40.00	2.43	....	....	7.1	35.8	[2]132	[3]157	157	10.3
140	34	38.30	2.72	....	....	....	40.1	146	169	....	8.5
141	[1]17	37.01	....	....	....	....	....	[2]204	[3]236	228	....
*150	[1]17	38.87	2.84	....	....	18.5	45.0	[2]160	[3]194	....	11.9
142	[1]17	40.70	3.30	....	....	....	41.2	[2]190	[3]224	218	10.3
143	[1]17	37.10	2.50	....	....	....	41.2	[2]131	[3]166	....	14.0
144	[1]17	39.85	2.79	....	....	....	39.7	[2]155	[3]188	180	18.0
145	[1]17	38.50	2.55	....	....	....	55.0	[2]152	[3]176	....	9.4
146	[1]17	35.65	2.98	....	....	11.1	56.3	[2]166	[3]190	184	8.1
147	[1]17	38.50	2.60	....	....	....	42.8	[2]143	[3]177	172	13.1
148	[1]17	44.64	3.30	....	....	....	33.8	[2]197	[3]233	221	9.0
149	[1]17	35.90	2.86	....	....	....	32.5	[2]136	[3]174	167	13.3
150	[1]17	37.61	2.43	....	....	....	45.5	[2]133	[3]156	....	9.5
151	28	36.70	2.86	....	....	8.3	48.6	156	186	180	10.5
*154	28	35.91	2.82	....	....	11.4	50.0	152	180	....	9.9
152	28	38.31	2.82	....	....	23.8	44.5	156	178	171	7.8
153	28	37.03	3.03	14.7	11.8	10.4	49.7	168	202	195	11.2
154	28	36.86	2.48	11.2	16.0	....	48.7	136	162	157	10.5
155	28	37.40	3.25	....	....	....	44.8	176	214	205	11.7
156	28	37.55	3.30	....	....	18.7	50.0	186	218	210	9.7
157	28	36.99	3.32	7.2	4.8	29.8	42.6	175	206	200	9.3
158	28	37.90	3.52	9.5	5.0	13.4	42.5	190	226	219	10.3
159	28	....	....	....	....	....	....	189	226	218	....
160	28	36.80	2.82	....	....	9.1	44.7	150	174	165	8.5
161	[1]30	35.09	2.70	17.7	11.0	8.1	62.5	[2]154	[3]180	174	9.6
*166	[1]30	40.33	2.13	....	....	10.8	30.5	[2]112	[3]135	....	10.8
162	[1]30	43.92	2.40	....	....	7.1	19.5	[2]126	[3]152	147	10.8
163	[1]30	38.00	3.43	....	....	6.5	57.3	[2]205	[3]235	226	8.8
164	[1]30	36.03	3.04	....	....	8.7	54.2	[2]169	[3]196	187	8.9
165	[1]30	33.28	3.64	....	....	10.9	57.0	[2]190	[3]233	227	11.8
166	[1]30	37.10	2.99	10.6	5.5	18.2	42.3	[2]158	[3]184	178	8.7
167	[1]30	40.59	2.81	....	....	14.0	40.3	[2]160	[3]186	180	9.3
168	[1]30	33.20	3.71	7.6	11.4	7.6	44.5	[2]178	[3]232	225	14.5
169	[1]30	33.12	3.47	23.9	18.5	6.3	55.0	[2]178	[3]217	211	11.2
170	[1]30	37.68	2.92	....	....	....	49.3	[2]164	[3]191	178	9.2
171	31	41.20	2.07	....	....	11.8	26.6	108	126	121	8.7
*176	31	36.49	2.43	....	....	10.0	50.0	133	160	....	11.1
172	31	33.85	2.94	17.2	19.0	9.3	59.7	159	193	190	11.6
173	31	44.70	2.82	....	....	7.0	29.4	163	193	188	10.6
174	31	42.05	2.13	....	....	16.7	30.7	117	137	133	9.4
175	31	37.10	1.92	....	....	6.7	39.0	99	124	123	13.0
176	31	39.99	2.76	8.7	10.0	9.3	41.4	156	182	178	9.4
177	31	39.40	1.92	10.0	12.9	14.3	41.5	107	124	121	8.9

* Sawed for penetration determinations, and therefore not laid in track.
[1] Re-treatment. [2] Weight before first treatment. [3] Weight after final treatment.

TABLE 7.—*General records on the individual ties*—Continued.

FULL-CELL CREOSOTE—RED OAK—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in—		Sapwood.	Moisture in tie when treated.	Weight of tie.			Absorption per cubic foot.
				Heartwood.	Sapwood.			Directly before treatment.	Directly after treatment.	Before laying in track.	
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
178	31	36.30	3.13	8.0	9.3	....	37.5	156	211	204	17.6
179	31	36.74	2.58	....	....	9.1	47.6	140	177	161	14.3
180	31	40.29	2.67	....	....	17.0	42.5	153	168	....	5.6
181	32	32.61	3.20	8.4	12.5	....	53.3	160	204	198	7.5
*185	32	39.06	2.69	....	....	8.3	42.8	150	171	....	10.8
182	32	38.81	2.38	....	....	24.2	32.0	122	150	144	11.8
183	32	39.30	2.55	....	....	....	37.7	138	166	160	11.0
184	32	38.56	1.99	....	....	15.8	51.1	116	146	134	12.1
185	32	37.28	2.43	9.2	8.0	11.3	46.7	133	159	142	7.8
186	32	33.45	2.67	8.0	6.6	15.9	54.5	138	173	167	12.4
187	32	40.08	3.13	....	....	17.0	35.6	170	202	198	10.5
188	32	39.05	2.72	....	....	12.5	41.1	150	178	170	10.7
189	32	33.92	2.36	8.7	8.0	8.6	57.5	126	154	147	11.9
190	32	38.20	2.18	....	....	15.1	45.4	121	144	143	10.6
191	33	34.84	2.98	....	....	10.6	41.6	147	188	183	13.1
*194	33	36.52	2.48	....	....	19.5	50.2	136	163	....	10.9
192	33	34.85	2.36	....	....	8.1	62.9	134	152	149	7.6
193	33	34.39	3.60	....	....	15.1	51.2	187	227	220	11.1
194	34	35.70	2.94	....	....	....	56.4	164	194	191	10.2
195	33	39.08	2.07	....	....	12.5	40.9	114	132	129	8.7
196	33	31.90	2.11	21.3	35.2	12.5	53.1	103	140	137	17.5
197	33	37.19	2.31	....	....	....	43.3	123	144	145	9.1
198	34	36.02	2.45	....	....	9.8	55.3	137	162	162	9.8
199	34	36.23	3.06	....	....	17.2	45.2	161	192	187	10.1
200	34	35.59	2.52	....	....	....	46.1	131	165	163	13.5

BURNETT—RED OAK.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in—		Sapwood.	Moisture in tie when treated.	Weight of tie.			Absorption per cubic foot.	
				Heartwood.	Sapwood.			Directly before treatment.	Directly after treatment.	Before laying in track.	Solution (3 per cent).	Dry salt.[1]
		Lbs.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
201	35	35.30	2.36	10.2	8.3	11.7	41.6	118	156	133	16.1	0.48
*204	35	36.94	2.18	....	....	23.8	45.3	117	149	....	14.9	.44
202	35	41.01	2.43	7.3	10.4	14.3	40.5	140	164	147	9.9	.30
203	35	36.03	2.11	10.3	5.0	13.1	42.0	108	140	115	15.2	.46
204	35	40.68	2.91	8.4	10.5	11.6	42.0	168	199	....	10.7	.32
205	35	40.00	2.72	....	....	15.5	40.6	153	187	164	12.5	.38
206	35	33.39	3.33	....	....	16.7	45.7	162	219	183	17.1	.51
207	35	39.36	2.86	....	....	5.0	43.9	162	199	175	12.9	.39
208	35	38.57	2.24	....	....	12.8	41.2	122	152	130	17.9	.54
209	35	38.98	2.33	....	....	15.4	48.6	135	160	135	10.7	.32
210	35	....	....	....	....	....	....	132	169	....	....	....
211	36	35.75	2.62	....	....	12.2	40.9	132	178	151	17.6	.53
*216	36	39.24	3.13	3.7	5.9	....	44.1	177	220	....	13.7	.41
212	36	38.34	2.40	....	....	8.9	44.5	133	166	141	13.7	.41
213	36	39.19	2.70	9.0	8.8	11.5	40.8	149	188	162	14.4	.43
214	36	36.81	2.14	....	....	18.7	40.9	111	148	125	17.3	.52
215	36	35.97	3.08	....	....	15.5	45.3	161	210	175	15.9	.48
216	36	34.59	2.81	8.4	12.5	27.0	48.1	144	194	164	17.8	.53

* Sawed for penetration determinations, and therefore not laid in track.
[1] Values calculated from pounds of solution absorbed per cubic foot.

TABLE 7.—*General records on the individual ties*—Continued.

BURNETT—RED OAK—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot. Solution (3 per cent).	Dry salt.
		Lbs.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
217	36	33.04	3.45				57.0	179	245	203	19.1	0.57
218	36	36.58	3.60				51.8	200	251	220	14.2	.43
219	36	37.54	3.20	11.0	8.0	12.1	40.6	169	222	187	16.6	.50
220	36	35.61	2.48			14.3	44.9	128	174	149	18.5	.55
221	38	34.46	2.70			10.5	41.8	132	194	163	23.0	.69
*225	38	37.67	3.42			9.1	47.5	190	246		16.4	.49
222	38	34.40	2.96			11.9	47.2	150	208	170	19.6	.59
223	38	38.06	3.16			8.3	53.0	184	220	194	11.4	.34
224	38	36.45	2.81	10.2	10.6	11.1	44.5	148	192	163	15.6	.47
225	38	39.65	3.26	7.1	6.3		42.2	184	232	197	14.7	.44
226	38	35.31	3.26			16.3	43.5	165	232	194	20.6	.62
227	38	35.80	3.01	9.9	14.5	13.3	50.4	162	212	181	16.6	.50
228	38	37.30	3.01			5.7	44.4	162	210	177	15.9	.48
229	38	36.22	2.89			8.7	46.2	153	196	170	14.9	.45
230	38	37.15	3.11	5.0	7.4	27.2	54.0	178	216	187	12.2	.37
231	39	35.76	2.98			7.0	40.7	150	204	194	18.1	.54
*236	39	34.11	2.94	8.0	9.0	10.9	49.6	150	198		16.3	.49
232	39	36.88	3.20			8.2	55.1	183	219	196	11.2	.34
233	39	35.24	3.37			5.9	47.4	175	233	203	17.2	.52
234	39	39.50	2.48	6.5	5.3	15.4	32.7	130	172	135	16.9	.51
235	39	34.28	3.15				46.3	158	214	189	17.8	.53
236	39	37.23	2.94	9.2	12.0	15.7	42.2	145	187	165	15.3	.40
237	39	33.41	3.37				48.4	167	226	200	17.5	.52
238	39	34.50	3.08	16.0	11.5	26.0	56.3	166	204	193	12.3	.37
239	39	34.51	3.54				46.5	179	230	206	14.4	.43
240	39	38.80	3.03			13.0	31.8	155	202	174	15.5	.46
241	40	36.88	3.13			7.4	45.5	168	220	186	16.6	.50
*242	40	37.02	2.43	6.8	10.6		43.4	129	170		16.9	.51
242	40	36.29	2.48				42.4	128	169	142	16.5	.50
243	40	35.06	3.25	7.5	12.8	13.7	50.0	171	232	194	18.8	.56
244	40	34.96	2.91	17.0	22.5	8.9	49.5	152	204	175	17.9	.54
245	40	38.58	2.55			11.1	45.4	143	200	162	22.4	.67
246	40	39.65	2.06			14.7	38.4	113	134	126	10.2	.31
247	40	39.31	2.64			9.5	44.5	150	190	162	15.2	.46
248	40	36.45	2.79			9.6	41.6	144	198	166	19.3	.58
249	40	32.22	2.81	22.3	20.0	7.2	52.4	138	178	153	14.2	.43
250	40	36.61	2.43			15.5	39.4	124	169	149	18.5	.55
251	41	32.50	2.18	8.2	12.0	9.8	63.7	116	146	122	13.8	.41
*251	41	38.21	2.40			10.0	35.2	124	164		16.7	.50
252	41	36.60	2.50	6.2	5.8	6.3	41.0	129	174	142	18.0	.54
253	41	32.98	3.44	23.2	10.7	5.9	59.5	181	226	190	13.1	.39
254	41	39.45	2.07			9.1	24.8	102	144	120	20.3	.61
255	41	36.30	2.67	23.5	12.8	10.6	36.1	132	190	155	21.7	.65
256	41	35.91	2.51			12.2	42.0	128	151	135	9.2	.28
257	41	35.31	2.41			11.4	48.0	126	169	141	17.8	.53
258	41	37.42	2.98			10.3	44.4	161	196	166	11.7	.35
259	41	38.83	2.11			13.5	50.1	123	159	127	17.0	.51
260	41	36.91	2.14			10.5	31.6	104	159	127	25.7	.77
261	42	40.75	2.31				34.9	127	163		15.6	.47
*266	42	36.12	2.43	7.7	8.0	15.0	43.5	126	169		17.7	.53
262	42	37.39	1.98			14.3	31.1	97	143	116	23.2	.70
263	42	39.08	2.04				48.0	118	144	127	12.8	.38
264	42	39.05	2.46			16.2	50.0	144	177	156	13.4	.40
265	42	34.90	2.86			9.3	50.4	150	210	177	21.0	.63
266	42	36.01	2.18	7.2	11.2	15.1	51.5	119		130	17.3	.52
267	42	37.62	2.30				36.4	118	162	138	19.1	.57
268	42	36.77	2.79	15.7	12.3	7.7	55.0	159	202	174	15.4	.46
269	42	34.60	1.97	12.5	11.7	9.7	42.2	97	136	115	19.8	.59
270	42	39.09	2.45			18.2	29.5	124	160	142	14.7	.44
271	43	36.33	3.30	20.4	6.3	8.6	48.5	178	234	205	17.0	.51
*271	43	38.27	2.77			7.8	35.8	144	200		20.2	.61
272	43	38.20	3.03	8.7	6.8	18.5	39.1	161	212	183	16.8	.50
273	43	36.59	2.28			13.5	39.0	116	164	135	21.0	.63
274	43	37.25	2.33			13.5	37.1	119	157	135	16.3	.49
275	43	34.78	2.41	11.2	9.7	14.3	56.3	131	172	143	17.0	.51
276	43	38.30	2.94	8.0	4.9		37.7	155	208	170	18.0	.54
277	43	34.35						152	241	195		
278	43	37.50	3.04				49.1	170	212	179	13.8	.41

* Sawed for penetration determinations, and therefore not laid in track.

TABLE 7.—*General records on the individual ties*—Continued.

BURNETT—RED OAK—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Average number of annual rings per inch in— Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Weight of tie. Directly after treatment.	Weight of tie. Before laying in track.	Absorption per cubic foot. Solution (3 per cent).	Absorption per cubic foot. Dry salt.
		Lbs.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
279	43	34.78	2.94	....	....	13.0	49.6	153	202	178	16.6	0.50
280	43	42.42	2.89	....	....	....	20.0	147	210	175	21.8	.65
281	44	41.31	3.71	....	....	9.4	34.4	206	270	229	17.3	.52
*283	44	34.82	3.18	10.6	16.0	4.5	48.2	164	227	....	19.8	.59
282	44	37.19	3.11	6.7	8.0	15.2	45.2	168	222	191	17.4	.52
283	44	35.58	3.28	....	....	10.0	34.6	157	238	197	24.7	.74
284	44	36.52	3.26	....	....	....	39.4	166	232	194	17.2	.61
285	44	37.52	2.70	5.8	7.0	12.8	43.1	145	193	166	17.8	.53
286	44	37.10	2.58	10.2	9.4	7.0	41.2	135	186	156	19.8	.59
287	44	39.10	2.89	....	....	10.4	36.4	154	207	171	18.3	.55
288	44	39.06	2.04	....	....	10.4	25.4	100	146	120	22.6	.68
289	44	38.47	2.84	....	....	16.7	41.0	154	205	176	18.0	.54
290	44	39.76	3.06	....	....	7.5	36.5	166	218	187	17.0	.51
291	45	38.11	2.70	19.7	17.1	11.0	39.9	144	192	163	17.8	.53
*291	45	35.89	2.38	....	....	20.6	47.5	126	168	....	17.7	.53
292	45	37.81	2.91	....	....	11.7	40.0	154	206	176	17.9	.54
293	45	36.02	2.04	....	....	11.4	48.2	109	145	119	17.6	.53
294	45	37.61	3.20	....	....	16.7	43.8	173	224	195	15.9	.48
295	45	36.39	2.47	....	....	9.3	39.1	125	169	145	17.8	.53
296	45	34.88	2.96	....	....	10.2	45.2	150	205	174	18.6	.56
297	45	38.60	2.84	....	....	10.6	45.0	159	199	174	14.1	.42
298	45	34.76	2.57	9.3	9.0	18.4	43.4	128	178	147	19.5	.58
299	45	35.55	2.57	20.2	16.0	7.9	51.1	138	183	153	17.5	.52
300	45	38.07	3.18	6.2	6.9	12.7	40.5	170	229	193	18.5	.55

BURNETT—MAPLE.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Average number of annual rings per inch in— Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Weight of tie. Directly after treatment.	Weight of tie. Before laying in track.	Absorption per cubic foot. Solution (2½ per cent).	Absorption per cubic foot. Dry salt.[1]
		Lbs.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
301	46	25.81	3.37	24.2	17.6	....	60.9	140	210	168	20.8	0.52
*305	46	35.15	3.09	....	....	57.2	22.6	133	179	....	14.9	.37
302	46	33.53	3.23	....	....	65.0	41.2	153	230	179	23.8	.59
303	46	33.20	4.38	30.6	26.6	27.7	34.1	195	248	206	12.1	.30
304	46	35.10	3.38	....	....	53.8	33.1	158	224	165	19.5	.49
305	46	35.20	2.65	22.7	40.0	74.0	38.4	129	202	140	27.5	.69
306	46	34.66	2.98	....	....	92.0	56.9	162	231	184	23.0	.58
307	46	29.39	3.25	....	....	70.5	47.6	141	210	163	21.2	.53
308	46	33.50	3.15	....	....	60.8	36.5	144	202	151	18.0	.46
309	46	31.62	3.33	25.0	15.8	56.2	35.0	142	209	169	20.1	.50
310	46	26.10	3.08	....	....	90.0	34.4	108	187	144	25.6	.64
311	47	39.70	3.01	27.2	26.0	68.2	27.3	152	197	158	14.9	.37
*319	47	38.99	3.15	....	....	....	33.5	164	228	....	20.3	.51
312	47	34.30	3.01	....	....	59.6	41.4	146	193	158	15.6	.39
313	47	31.42	2.96	....	....	....	29.0	120	171	140	17.2	.43
314	47	33.75	3.06	....	....	86.5	39.4	144	212	166	22.2	.55
315	47	38.00	2.65	13.8	13.0	75.0	31.1	132	192	144	22.6	.56
316	47	35.69	2.86	....	....	55.0	43.1	146	194	154	16.8	.42
317	47	36.16	3.44	....	....	64.5	32.7	165	236	185	20.6	.51
318	47	30.80	2.89	....	....	43.3	29.2	115	166	130	17.6	.44
319	47	34.79	2.70	30.7	26.0	89.4	29.9	122	188	146	24.4	.61
320	47	35.35	3.15	23.5	9.0	75.4	42.7	159	218	166	18.7	.47

* Sawed for penetration determinations, and therefore not laid in track.
[1] Values calculated from pounds of solution absorbed per cubic foot.

TABLE 7.—*General records on the individual ties*—Continued.

BURNETT—MAPLE—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot. Solution (2½ per cent).	Dry salt.
		Lbs.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
321	48	34.40	3.15	14.1	12.0	91.1	21.8	132	206	154	23.5	0.59
*326	48	30.83	3.06	....	....	....	31.4	124	182	....	18.9	.47
322	48	31.67	3.11	....	....	54.2	25.8	124	180	139	18.0	.45
323	48	31.11	3.10	....	....	76.5	29.6	125	202	140	24.8	.62
324	48	35.43	3.38	....	....	82.8	27.8	153	224	171	21.0	.52
325	48	32.72	3.26	....	....	63.3	27.5	136	200	158	19.6	.49
326	48	35.75	3.03	....	....	....	34.7	146	214	167	22.5	.56
327	48	....	2.65	22.9	17.5	56.3	....	96	170	122	28.0	.70
328	48	32.75	2.53	26.4	8.8	91.2	34.0	111	176	129	25.7	.64
329	48	34.90	2.74	....	....	70.0	30.8	125	186	134	22.3	.56
330	48	33.64	3.32	18.3	21.8	60.8	32.4	148	198	157	15.1	.38
331	49	34.02	3.79	....	....	74.0	38.0	178	266	189	23.2	.58
*339	49	26.45	3.72	....	....	54.1	30.1	128	208	....	21.5	.54
332	49	28.67	3.40	....	....	86.2	39.6	136	211	159	22.1	.55
333	49	36.10	2.92	18.9	18.3	49.0	36.6	144	189	143	15.3	.38
334	49	38.76	3.86	15.7	10.9	25.4	35.0	202	265	210	16.4	.41
335	49	36.98	3.25	15.0	25.0	69.5	38.1	166	237	175	21.8	.54
336	49	33.07	3.97	....	....	84.0	29.5	170	280	190	27.8	.69
337	49	37.30	2.96	....	....	83.5	34.1	148	208	153	20.3	.51
338	49	31.50	3.06	....	....	57.0	32.7	128	192	134	20.9	.52
339	49	34.28	2.58	....	....	96.6	31.1	116	186	126	27.2	.68
340	49	34.85	3.15	19.0	8.0	74.5	36.6	150	228	158	24.7	.62
341	50	37.43	3.75	20.6	12.3	66.6	12.6	158	214	170	17.2	.43
*350	50	36.40	3.27	....	....	51.0	31.0	156	214	....	17.8	.44
342	50	....	....	....	....	....	....	134	204	157	....	....
343	50	29.70	3.21	18.8	21.3	42.6	38.5	132	186	148	16.8	.42
344	50	34.20	3.70	30.0	20.5	45.2	18.5	150	204	164	14.6	.36
345	50	35.64	2.65	....	....	81.5	37.6	130	188	149	21.9	.55
346	50	29.90	2.58	....	....	82.5	42.6	110	170	126	23.3	.58
347	50	34.02	2.93	18.8	31.8	92.0	32.4	132	190	148	19.8	.49
348	50	37.80	2.86	....	....	53.6	31.4	142	194	152	18.2	.45
349	50	33.32	2.36	....	....	33.3	37.3	108	134	119	11.0	.27
350	50	35.32	3.32	....	....	38.7	36.4	160	206	161	13.9	.35
351	51	34.82	3.08	....	....	68.0	26.7	136	212	....	24.7	.62
*360	51	33.07	3.08	19.7	20.3	38.5	32.5	135	194	....	19.2	.48
352	51	36.10	2.81	....	....	72.7	34.0	136	202	142	23.5	.59
353	51	35.38	3.13	....	....	79.0	37.2	152	227	157	24.0	.60
354	51	34.91	3.06	24.0	16.7	31.3	29.1	138	189	143	16.7	.42
355	51	33.98	3.10	....	....	29.0	36.7	144	186	151	13.6	.34
356	51	36.89	3.13	33.3	8.8	41.7	38.6	160	214	171	17.3	.43
357	51	36.27	2.93	21.7	13.3	83.4	34.6	143	214	162	24.2	.60
358	51	36.92	2.86	....	....	46.7	29.7	137	188	145	17.9	.45
359	51	34.86	2.82	....	....	86.5	33.2	131	192	136	21.6	.54
360	51	35.79	3.08	....	....	34.8	30.7	144	184	144	13.0	.32
361	52	30.30	3.27	....	....	69.0	28.1	127	210	160	25.4	.63
*364	52	36.09	2.67	....	....	....	31.7	127	189	....	23.2	.58
362	52	32.82	3.11	....	....	62.6	43.0	146	228	174	26.4	.66
363	52	33.42	3.30	....	....	56.7	38.6	153	231	162	23.6	.59
364	52	32.14	2.91	....	....	40.0	32.5	124	158	126	11.7	.29
365	52	37.62	3.38	20.1	30.0	33.0	29.0	164	222	181	17.2	.43
366	52	35.37	3.04	10.3	8.2	82.2	35.7	146	230	158	27.6	.69
367	52	37.86	2.89	....	....	59.2	32.5	145	212	154	23.2	.58
368	52	38.53	2.94	26.5	18.1	63.2	28.9	146	198	151	17.7	.44
369	52	36.73	3.42	....	....	62.5	37.0	172	238	174	19.3	.48
370	52	34.69	2.81	30.0	30.9	59.5	29.3	126	194	143	24.2	.60
371	53	37.15	3.03	....	....	87.6	27.9	144	215	175	23.0	.59
*372	53	29.14	3.37	....	....	....	40.5	138	204	....	19.6	.49
372	53	36.22	2.87	16.0	21.1	78.2	38.5	144	204	160	20.9	.52
373	53	33.82	3.47	23.4	22.0	65.4	34.5	158	217	174	17.0	.42
374	53	35.79	3.08	....	....	....	30.6	144	225	171	26.4	.66
375	53	32.89	3.40	....	....	28.6	27.0	142	188	153	13.6	.34
376	53	35.60	3.11	....	....	69.0	30.0	144	203	161	18.9	.47
377	53	31.43	3.25	15.7	22.5	83.0	43.0	146	230	175	25.8	.64
378	53	34.95	2.74	21.8	21.8	80.7	44.0	138	186	146	17.5	.44
379	53	34.10	3.85	....	....	69.2	34.0	176	246	191	18.2	.45
380	53	37.80	2.53	....	....	43.2	42.2	136	172	140	14.2	.35
381	54	34.60	2.52	....	....	67.4	26.2	110	130	106	7.9	.20

* Sawed for penetration determinations, and therefore not laid in track.

TABLE 7.—*General records on the individual ties*—Continued.

BURNETT—MAPLE—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot. Solution (2½ per cent).	Dry salt.
		Lbs.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
*381	54	34.45	3.06	......	......	......	33.6	141	190	......	16.0	0.40
382	54	35.77	3.67	20.0	22.5	55.0	43.9	189	227	192	10.4	.26
383	54	34.01	2.36	......	......	63.5	29.5	104	151	113	19.9	.50
384	54	35.00	3.54	......	......	......	37.0	170	222	177	14.7	.37
385	54	35.10	3.01	27.8	15.0	89.5	36.2	144	202	151	19.3	.48
386	54	31.70	3.25	......	......	......	46.5	151	222	174	21.8	.54
387	54	32.05	2.72	21.2	18.3	50.0	29.6	113	158	122	16.6	.41
388	54	34.10	2.70	16.1	21.5	85.2	45.5	134	186	145	19.3	.48
389	54	35.46	3.01	......	......	76.5	40.6	150	212	160	20.6	.51
390	54	35.48	3.13	......	......	80.5	36.7	152	210	167	18.5	.46
391	55	34.66	3.71	......	......	56.6	38.4	178	248	186	18.9	.47
*392	55	33.48	3.16	......	......	72.6	43.7	152	234	......	25.9	.65
392	55	30.75	3.09	......	......	58.4	41.0	134	194	138	19.5	.49
393	55	......	......	......	......	......	......	144	210	157	......	......
394	55	......	......	......	......	......	......	114	198	140	......	......
395	55	32.87	3.66	......	......	......	43.0	172	272	212	27.2	.68
396	55	34.90	3.09	20.0	8.2	......	46.5	158	236	169	25.2	.63
397	55	31.27	2.55	25.5	12.7	......	22.7	98	172	125	29.0	.72
398	55	33.85	3.08	......	......	......	43.9	150	216	163	21.4	.53
399	55	28.96	3.20	44.5	20.0	79.6	31.8	134	224	163	28.0	.70
400	55	36.13	3.45	12.6	22.8	69.4	44.4	180	242	184	18.0	.45

RUEPING—MAPLE.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
401	65	30.30	3.37	......	......	66.6	26.4	129	151	148	6.54
*405	65	28.47	3.82	18.1	13.3	62.7	30.6	142	166	......	6.30
402	65	32.93	3.73	......	......	......	35.1	166	184	185	4.83
403	65	32.20	2.64	......	......	77.4	34.1	114	132	127	6.82
404	65	29.10	4.41	20.0	11.1	50.0	30.9	168	190	187	5.00
405	65	29.76	2.79	......	......	......	27.7	106	129	125	8.25
406	65	30.91	2.77	......	......	57.4	26.1	108	132	120	8.66
407	65	32.02	3.20	27.6	30.0	70.0	32.7	136	147	145	3.44
408	65	25.79	2.79	24.0	16.0	......	30.6	94	109	114	5.38
409	65	30.93	3.20	......	......	......	30.3	129	151	146	6.90
410	65	30.33	2.55	......	......	......	30.6	101	122	120	8.25
411	66	35.40	3.15	......	......	65.5	34.5	150	160	144	3.17
*411	66	36.13	2.86	22.0	16.9	69.5	30.6	135	147	......	4.20
412	66	35.78	3.11	21.4	19.3	66.6	32.8	148	160	159	3.86
413	66	34.90	2.45	20.0	22.6	62.0	26.4	108	116	115	3.26
414	66	35.03	2.67	......	......	70.0	32.6	124	132	130	3.00
415	66	36.50	3.16	......	......	51.0	31.8	152	158	157	1.90
416	66	34.25	3.18	......	......	70.5	28.5	140	156	150	5.03
417	66	34.42	2.99	......	......	70.8	24.4	128	142	140	4.68
418	66	36.75	2.84	......	......	......	30.3	136	144	142	2.82
419	66	36.77	3.08	27.1	17.8	......	25.4	142	155	153	4.23
420	66	34.25	3.84	......	......	71.6	32.3	174	187	182	3.30
421	67	37.18	3.08	......	......	67.4	30.1	149	167	163	5.84
*430	67	34.72	3.15	......	......	87.7	29.7	142	156	......	4.44
422	67	36.01	3.15	......	......	82.7	26.9	144	156	153	3.81
423	67	37.20	2.48	18.7	20.0	80.0	32.3	122	134	129	4.84

* Sawed for penetration determinations, and therefore not laid in track.

TABLE 7.—*General records on the individual ties*—Continued.

RUEPING—MAPLE—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
424	67	30.10	3.32	12.6	33.6	47.1	32.1	132	144	141	3.62
425	67	35.30	2.79	28.9	21.5	61.6	32.0	130	142	139	4.30
426	67	30.10	3.66	....	....	42.6	30.6	144	162	155	4.92
427	67	35.87	3.38	....	....	71.6	31.1	159	172	168	3.85
428	67	33.78	3.04	....	....	....	29.6	133	146	145	4.30
429	67	37.20	3.06	....	....	53.2	24.8	142	156	151	4.58
430	67	35.54	3.30	12.6	18.0	52.5	30.4	153	172	164	5.75
431	62	34.53	2.52	18.0	15.5	....	26.4	110	118	117	3.20
*434	62	34.25	2.58	39.8	20.5	....	32.5	117	134	....	6.60
432	62	38.34	3.30	18.0	25.0	45.0	31.9	167	182	179	4.56
433	62	35.93	2.45	....	....	55.1	28.3	113	127	125	4.68
434	62	35.15	2.69	....	....	....	29.0	122	144	130	8.20
435	62	32.13	2.81	....	....	....	29.5	117	141	137	8.54
436	62	36.85	2.81	....	....	....	26.5	131	154	140	8.20
437	62	36.62	3.13	....	....	79.3	30.0	149	170	165	6.70
438	62	36.46	3.19	....	....	75.5	32.4	154	179	175	7.84
439	62	33.90	2.65	27.4	25.8	....	32.6	119	135	131	6.04
440	62	37.52	3.03	....	....	78.1	29.3	147	166	164	6.28
441	68	28.67	3.16	....	....	....	60.0	145	159	156	4.42
*450	68	30.70	3.01	16.9	21.5	60.4	35.2	125	138	....	4.32
442	68	35.63	2.89	....	....	....	22.4	126	136	134	3.46
443	68	....	2.62	....	....	71.4	....	122	132	129	3.82
444	68	35.97	3.49	....	....	80.7	30.6	164	178	173	4.02
445	68	34.75	2.86	....	....	....	27.7	127	137	135	3.50
446	68	36.78	3.06	....	....	....	33.3	150	166	163	5.23
447	68	37.88	3.25	....	....	56.6	27.5	157	175	167	5.54
448	68	36.74	2.99	30.0	13.3	90.7	23.8	136	151	152	5.02
449	68	36.30	2.99	26.0	33.2	51.3	31.7	143	154	150	3.70
450	68	37.90	3.01	26.0	25.3	64.7	28.9	147	160	157	4.32
451	69	35.47	3.90	....	....	58.1	31.6	182	199	193	4.36
*460	69	34.69	3.41	....	....	....	21.7	144	155	....	3.26
452	69	37.20	2.57	16.9	15.1	81.0	26.7	121	136	134	5.45
453	69	26.92	3.86	24.6	14.2	75.4	30.8	136	162	154	6.73
454	69	35.97	3.42	....	....	89.6	27.6	157	177	174	5.86
455	69	36.21	2.79	....	....	63.8	27.7	129	142	140	4.36
456	69	35.60	3.21	....	....	70.6	28.6	147	166	160	5.61
457	69	35.87	3.11	....	....	40.5	30.0	145	157	154	3.86
458	69	30.10	2.89	22.7	20.8	80.8	34.5	117	135	130	6.23
459	69	33.82	3.03	....	....	....	32.6	136	149	145	3.96
460	69	34.70	2.91	27.2	19.7	64.6	28.7	130	147	141	5.84
461	70	33.60	5.89	19.8	16.5	74.4	10.2	218	246	241	4.76
*467	70	31.57	2.86	....	....	60.9	34.1	121	135	....	4.90
462	70	30.32	2.76	....	....	71.6	26.7	106	123	119	6.16
463	70	35.53	2.77	18.0	20.0	52.1	34.1	132	141	141	3.25
464	70	30.84	....	12.8	28.5	....	....	164	184	179	....
465	70	37.02	3.08	....	....	....	27.1	145	159	159	4.53
466	70	35.80	3.33	....	....	60.0	31.7	157	169	166	3.61
467	70	....	2.47	21.1	26.1	....	....	115	129	124	5.68
468	70	31.02	2.64	....	....	....	31.8	108	126	122	6.82
469	70	27.90	3.08	....	....	81.1	28.1	110	130	127	6.50
470	70	32.50	3.85	....	....	62.5	19.9	150	165	165	3.90
471	71	32.30	2.84	....	....	82.4	35.1	124	141	139	6.00
*476	71	35.20	3.28	17.8	21.6	82.3	33.4	154	170	....	4.90
472	71	33.44(?)	2.77(?)	....	....	....	37.2(?)	127	144	142	6.14
473	71	33.00	2.99	15.2	17.1	81.1	35.8	134	154	149	6.70
474	71	34.20	3.47	....	....	....	37.4	163	178	173	4.32
475	71	35.07	3.23	....	....	74.0	36.8	155	170	165	4.65
476	71	34.10	3.25	....	....	56.4	36.2	151	163	157	3.70
477	71	31.00	2.81	....	....	65.2	37.7	120	132	132	4.27
478	71	35.60	3.50	19.8	20.7	....	34.8	168	182	181	4.00
479	71	....	....	14.6	15.4	....	....	133	158	154	....
480	71	29.73	3.37	....	....	73.5	37.7	138	154	150	4.76
481	72	36.04	3.49	....	....	....	33.5	168	182	177	4.00
*487	72	35.60	2.55	24.1	33.3	35.9	57.6	143	154	....	4.33
482	72	39.31	2.99	19.0	11.7	87.3	40.4	165	182	177	5.69
483	72	31.78	3.45	....	....	33.3	37.8	151	163	161	3.48
484	72	33.90	3.57	....	....	36.2	33.0	161	172	170	3.08
485	72	28.70	2.96	....	....	....	34.2	114	128	123	4.73

* Sawed for penetration determinations, and therefore not laid in track.

TABLE 7.—*General records on the individual ties*—Continued.

RUEPING—MAPLE—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Average number of annual rings per inch in— Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Weight of tie. Directly a ter treatment.	Weight of tie. Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
486	72	36.83	3.09	....	....	58.7	35.4	154	166	164	3.88
487	72	34.04	2.64	20.0	17.2	77.8	32.5	119	129	128	3.78
488	72	35.18	3.30	....	....	83.3	32.5	154	171	168	5.15
489	72	37.80	3.52	....	....	26.4	29.3	172	188	184	4.54
490	72	35.35	2.67	14.0	16.3	81.8	35.6	128	144	141	6.00
491	73	33.18	2.75	....	....	56.6	23.9	113	126	124	4.72
*494	73	35.50	2.92	....	....	....	23.5	128	139		3.77
492	73	37.31	2.91	....	....	44.4	26.2	137	143	141	2.06
493	73	....	2.02	24.0	13.7	....	....	102	119	115	5.82
494	73	36.05	2.98	....	....	69.7	25.6	135	146	146	3.70
495	73	34.83	2.87	....	....	81.8	37.0	137	151	148	4.90
496	73	37.40	2.84	19.5	18.5	77.4	25.2	133	149	143	5.64
497	73	36.83	2.52	19.1	18.7	57.6	29.4	120	126	127	2.38
498	73	38.13	3.06	....	....	68.7	26.8	148	162	157	4.57
499	73	36.36	2.84	....	....	66.0	27.9	132	142	136	3.52
500	73	34.80	3.01	21.2	21.2	....	29.8	136	146	144	3.32

FULL-CELL CREOSOTE—MAPLE.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Directly before treatment.	Directly a ter treatment.	Before laying in track.	Absorption per cubic foot.
501	57	35.27	3.13	25.6	31.2	92.2	34.1	148	172	170	7.7
*508	57	38.80	2.86	....	....	12.4	34.3	149	176	....	9.4
502	57	34.19	3.35	16.9	15.5	67.9	37.1	157	180	175	6.9
503	57	36.43	3.54	....	....	69.2	46.5	189	204	200	4.2
504	57	35.78	3.79	....	....	....	34.2	182	220	210	10.0
505	57	33.60	3.25	....	....	78.7	56.6	171	222	215	15.6
506	57	36.27	3.30	20.6	21.0	48.3	32.8	159	194	186	10.6
507	57	33.24	2.74	....	....	17.8	43.7	131	170	166	14.2
508	57	35.78	3.41	....	....	60.5	26.2	154	184	183	9.7
509	57	31.70	3.86	12.0	15.0	45.4	31.6	161	210	201	12.6
510	57	37.40	3.18	....	....	....	32.8	158	207	199	15.4
511	[1] 59	30.75	3.08	....	....	....	57.2	[2] 149	[3] 196	192	15.3
*514	[1] 59	32.40	2.64	....	....	....	26.3	[2] 108	[3] 152	....	14.3
512	[1] 59	31.49	3.01	....	....	61.8	29.8	[2] 123	[3] 173	168	16.6
513	[1] 59	30.60	2.77	23.3	35.0	42.2	30.9	[2] 111	[3] 137	135	9.3
514	[1] 59	38.30	3.37	17.0	21.1	54.7	40.2	[2] 181	[3] 228	222	14.1
515	[1] 59	33.39	2.89	14.3	24.0	79.8	31.7	[2] 127	[3] 190	183	21.8
516	[1] 59	34.84	3.92	18.2	18.4	71.6	37.7	[2] 188	[3] 253	245	16.6
517	[1] 59	34.66	2.98	....	....	....	35.6	[2] 140	[3] 186	179	15.4
518	[1] 59	38.06	2.99	....	....	43.5	35.3	[2] 154	[3] 189	187	12.4
519	[1] 59	36.57	2.96	....	....	45.0	31.3	[2] 142	[3] 185	178	14.5
520	[1] 59	32.96	3.66	....	....	60.0	32.7	[2] 160	[3] 217	207	15.6
521	60	30.37	3.21	....	....	73.4	31.3	128	180	177	16.2
*527	60	36.11	3.08	18.9	14.1	76.5	31.2	146	190	....	14.2
522	60	35.15	3.09	....	....	65.6	30.8	142	210	....	22.0
523	60	27.34	3.43	17.8	15.3	60.0	32.1	124	157	....	9.6
524	60	38.30	2.94	22.3	16.8	83.0	27.0	143	190	185	16.3
525	60	38.80	2.43	....	....	56.8	30.4	123	152	146	11.9
526	60	35.20	....	....	....	....	....	114	189	183	....
527	60	27.58	3.99	....	....	....	34.5	148	198	193	12.5
528	60	35.48	3.08	....	....	68.7	31.8	144	196	190	16.9
529	60	....	....	....	....	....	....	134	193	175	....
530	60	36.24	3.50	18.6	7.8	49.6	32.4	168	205	....	10.6
531	[1] 64	34.58	....	....	....	....	....	[2] 200	[3] 236	230	....
*533	[1] 64	33.08	2.75	25.0	12.3	24.3	30.8	[2] 119	[3] 146	....	9.8
532	[1] 64	34.79	3.15	....	....	32.3	24.2	[2] 136	[3] 157	152	6.7
533	[1] 64	35.70	2.69	30.4	32.0	78.9	21.8	[2] 117	[3] 150	143	12.3
534	[1] 64	33.53	2.92	....	....	....	34.8	[2] 132	[3] 156	151	8.2
535	[1] 64	33.00	2.64	....	....	....	26.2	[2] 110	[3] 142	....	12.2
536	[1] 64	33.79	3.52	....	....	53.0	26.2	[2] 150	[3] 172	169	6.3
537	[1] 64	33.30	2.67	....	....	....	29.4	[2] 115	[3] 142	140	10.1
538	[1] 64	33.85	3.49	21.2	22.0	84.0	29.5	[2] 153	[3] 196	191	12.3
539	[1] 64	35.87	2.70	21.8	12.0	78.4	30.2	[2] 126	[3] 156	151	11.1
540	[1] 64	32.23	4.15	....	....	73.0	35.2	[2] 181	[3] 236	229	13.3
541	76	31.55	2.74	24.4	22.9	....	35.4	117	142	140	9.1

* Sawed for penetration determinations, and therefore not laid in track.
[1] Re-treatment. [2] Weight before first treatment. [3] Weight after final treatment.

TABLE 7.—*General records on the individual ties*—Continued.

FULL-CELL CREOSOTE—MAPLE—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in—		Sapwood.	Moisture in tie when treated.	Weight of tie.			Absorption per cubic foot.
				Heartwood.	Sapwood.			Directly before treatment.	Directly after treatment.	Before laying in track.	
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
*546	76	33.39	2.84	......	......	75.0	34.0	127	156	......	10.2
542	76	34.03	2.81	......	......	85.5	33.9	128	178	173	17.8
543	76	33.05	3.21	......	......	86.5	36.7	145	179	178	10.6
544	76	34.76	3.35	20.0	18.0	56.0	32.1	154	184	180	9.0
545	76	31.96	3.65	14.2	16.6	63.3	41.4	165	198	194	9.1
546	76	37.40	2.65	35.8	28.1	74.7	29.1	128	154	149	9.8
547	76	37.51	2.84	......	......	63.6	35.2	144	165	160	7.4
548	76	39.35	2.70	......	......	81.1	23.4	131	156	153	9.3
549	76	......	......	......	......	......	......	146	173	168	......
550	76	34.20	2.89	......	......	66.0	23.6	122	149	146	9.3
551	74	36.10	2.82	18.7	23.7	40.0	29.6	132	156	154	8.5
*560	74	36.40	3.73	......	......	70.4	32.5	180	222	......	11.3
552	74	38.48	2.55	24.4	20.9	58.7	27.3	125	154	151	11.4
553	74	33.78	3.43	......	......	60.7	36.4	158	182	177	7.0
554	74	33.43	4.10	11.4	15.2	86.5	25.4	172	223	219	12.5
555	74	32.60	3.35	......	......	41.3	31.9	144	171	164	8.1
556	74	35.43	2.84	......	......	36.7	33.3	134	159	156	8.8
557	74	34.77	3.38	......	......	74.0	31.1	154	185	182	9.2
558	74	36.43	2.84	......	......	65.0	27.5	132	170	165	13.4
559	74	35.14	3.03	......	......	60.0	28.6	137	180	176	14.2
560	74	34.30	3.71	22.5	15.5	35.0	31.2	167	202	185	9.4
561	77	34.34	2.55	......	......	76.4	31.3	115	150	147	13.7
*565	77	35.92	3.93	......	......	75.0	35.4	191	236	......	11.4
562	77	33.87	3.57	34.7	22.0	74.0	30.8	158	207	203	13.7
563	77	36.66	3.20	16.4	25.0	30.2	33.0	156	182	178	8.1
564	77	36.20	3.45	21.3	18.0	23.8	31.4	164	194	190	8.7
565	77	35.50	2.82	......	......	69.5	29.9	130	172	168	14.9
566	77	38.00	3.60	......	......	42.0	26.4	173	225	222	14.4
567	77	34.83	3.54	21.0	22.5	......	46.0	180	243	237	17.8
568	77	32.54	2.82	......	......	50.0	19.8	110	164	160	19.1
569	77	36.54	3 01	......	......	82.0	27.2	140	187	184	15.6
570	77	35.00	3.54	......	......	......	32.3	164	195	195	8.8
571	78	37.25	3.03	......	......	48.7	34.6	152	176	174	7.9
*576	78	38.70	2.74	......	......	......	28.3	136	163	......	9.9
572	78	29.51	......	......	......	......	......	152	189	186	......
573	78	36.92	3.08	15.6	11.8	39.0	32.0	150	189	186	12.7
574	78	36.72	3.66	23.8	26.0	79.8	28.0	172	210	207	10.4
575	78	36.94	3.21	......	......	41.0	31.4	156	182	178	8.1
576	78	36.55	2.74	......	......	83.4	23.8	124	164	161	14.6
577	78	34.80	3.48	......	......	60.8	33.8	162	191	186	8.4
578	78	37.50	3.08	31.3	18.1	82.0	24.7	144	187	185	14.0
579	78	35.60	2.86	......	......	57.2	29.6	132	161	158	10.2
580	78	30.76	......	15.6	18.0	......	......	160	202	198	......
581	79	35.46	2.94	......	......	67.6	32.5	138	186	183	16.3
*589	79	25.28	2.65	25.0	22.7	21.2	59.7	107	147	......	15.1
582	79	38.16	3.33	......	......	......	29.1	164	209	202	13.5
583	79	37.91	3.38	......	......	64.0	27.9	164	209	208	13.3
584	79	36.71	3.21	......	......	76.0	36.6	161	206	180	14.0
585	79	39.12	3.44	25.5	12.5	25.8	38.2	186	236	233	14.5
586	79	30.73	3.13	19.1	15.0	31.0	36.2	131	164	157	10.6
587	79	34.71	3.15	......	......	......	38.1	151	196	190	14.3
588	79	31.91	3.72	......	......	86.0	39.0	165	236	230	19.0
589	79	32.60	3.13	......	......	71.0	26.4	129	182	......	16.9
590	79	29.70	3.88	23.1	20.4	45.3	33.7	154	216	209	15.9
591	80	35.43	2.94	17.0	13.3	38.8	30.5	136	174	168	12.9
*594	88	36.30	3.56	25.7	22.8	67.0	32.4	171	215	......	12.4
592	80	32.90	2.55	......	......	......	31.2	110	144	137	13.3
593	80	34.07	2.30	......	......	87.0	22.4	96	135	125	17.0
594	80	37.59	3.16	20.0	14.6	62.6	28.1	152	190	183	12.0
595	80	37.45	3.23	......	......	40.1	36.5	165	191	180	8.1
596	80	34.20	2.50	......	......	50.2	28.6	110	142	137	12.8
597	80	35.44	2.89	......	......	26.7	30.8	134	164	157	10.4
598	80	33.66	2.88	17.3	19.9	48.8	34.0	130	171	165	14.2
599	80	35.89	3.20	......	......	38.6	33.3	153	186	......	10.3
600	80	32.09	3.03	......	......	62.0	37.8	134	177	172	14.2

* Sawed for penetration determinations, and therefore not laid in track.

TABLE 7.—*General records on the individual ties*—Continued.

GAS-HOUSE OIL—RED OAK.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
601	122	37.72	2.43				50.6	138	146	141	3.30
*609	122	36.13	2.77				62.7	163	178	....	5.41
602	122	35.64	2.87				47.6	151	162	155	3.81
603	122	34.12	3.04	6.2	6.3		57.2	163	182	171	6.25
604	122	32.21	3.06	17.8	16.1		66.4	164	174	170	3.26
605	122	33.85	2.75	16.3	14.2		56.8	146	168	159	8.0
606	122	35.10	3.35				63.3	192	208	200	4.75
607	122	37.48	2.40				42.4	128	138	132	4.28
608	122	35.29	2.91				55.9	160	188	181	9.6
609	122	33.66	2.94	10.0	8.5		59.7	158	169	162	3.74
610	122	35.00	2.98				58.3	165	178	170	4.36
611	123	36.21	2.92				46.6	155	188	184	11.3
*616	123	34.70	2.64				56.1	143	172	....	11.0
612	123	35.49	2.92	20.8	16.5		46.9	152	192	185	13.7
613	123	33.44	2.35	16.4	21.5		50.3	118	148	142	12.8
614	123	36.21	2.30				50.1	125	141	....	16.9
615	123	35.26	3.04	7.8	10.9		41.0	151	197	182	15.2
616	123	37.71	3.59				38.8	188	231	221	12.0
617	123	36.39	2.81				51.7	155	180	179	8.9
618	123	39.19	2.43				41.8	135	160	155	10.3
619	123	35.15	3.03	8.0	10.7		48.4	158	190	183	10.6
620	123	36.31	3.23				48.4	174	204	200	9.3
621	124	38.44	2.38				33.5	122	147	144	10.5
*624	124	36.21	3.08	8.0	11.7		50.6	168	202	....	11.1
622	124	37.18	2.70				43.5	144	181	176	13.7
623	124	39.80	2.09	8.5	15.0		37.1	114	137	132	11.0
624	124	37.18	2.69				41.0	141	166	163	9.3
625	124	36.61	2.50				48.5	136	160	153	9.6
626	124	37.02	2.89				42.0	152	190	184	13.2
627	124	34.45	2.84				46.2	143	178	175	12.3
628	124	35.03	3.04	13.6	14.2		53.1	163	200	195	12.2
629	124	35.71	3.49	13.8	13.8		49.3	186	230	222	12.6
630	124	36.61	2.81				50.5	155	184	179	10.3
631	125	40.81	2.62	8.7	8.0		30.8	140	165	163	9.5
*634	125	35.10	2.57				48.5	134	154	....	7.8
632	125	35.89	2.53	18.8	29.1		42.2	129	163	157	13.4
633	125	34.85	2.21				48.0	114	143	140	13.1
634	125	35.15	2.87				62.5	164	170	167	2.09
635	125	35.80	2.67				48.5	142	168	162	9.7
636	125	38.68	2.70	19.6	16.0		57.0	164	172	167	2.96
637	125	35.80	2.84	8.6	8.1		59.4	162	176	172	4.93
638	125	35.10	3.21				55.4	175	206	198	9.6
639	125	35.00	3.08				71.6	185	200	194	4.87
640	125	37.89	2.53				56.6	150	160	154	3.95
641	132	39.71	2.74				36.0	148	166	158	6.58
*648	132	39.70	3.47				50.2	207	233	....	7.50
642	132	35.95	3.26	5.3	5.0		62.0	190	208	200	5.54
643	132	36.09	2.48	9.0	12.5		58.6	142	156	150	5.64
644	132	36.51	2.74				54.0	154	165	157	4.02
645	132	36.05	2.55				61.0	148	169	161	8.2
646	132	38.43	3.08	4.8	3.6		22.9	145	163	157	5.66
647	132	36.82	2.57				40.5	133	161	157	10.9
648	132	37.51	2.59	10.0	15.1		48.3	144	167	161	8.9
649	132	38.80	2.94				48.1	169	191	182	7.5
650	132	38.22	2.53				40.6	136	157	151	8.3
651	133	38.80	2.81				47.6	161	178	172	6.02
*658	133	36.04	3.20	8.2	6.6		60.4	185	206	....	6.56
652	133	36.40	2.69				56.2	153	178	168	9.3
653	133	38.19	2.77				51.2	160	180	173	7.20
654	133	31.03	3.47				65.2	178	194	189	4.62
655	133	34.31	2.84				62.1	158	182	173	8.5
656	133	35.13	3.09				65.0	179	198	187	6.14
657	133	37.10	3.01	13.4	10.0		55.8	174	188	180	4.65
658	133	33.30	3.13	9.7	11.1		59.5	166	182	174	5.11
659	133	36.91	2.84	3.5	4.6		50.6	158	180	172	7.75
660	133	39.00	2.98				44.5	168	190	184	7.40
661	134	36.65	2.38				55.8	136	154	149	7.56

* Sawed for penetration determinations, and therefore not laid in track.

TABLE 7.—*General records on the individual ties*—Continued.

GAS-HOUSE OIL—RED OAK—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
*664	134	35.29	2.67	16.1	11.5	....	67.7	158	172	....	5.24
662	134	35.73	2.60	5.7	8.1	....	61.5	150	166	160	6.16
663	134	33.39	2.62	31.7	....	....	67.0	146	162	153	6.10
664	134	38.81	2.48	....	....	....	52.6	147	152	146	2.01
665	134	41.00	2.55	....	....	....	34.0	140	156	150	6.28
666	134	37.60	2.41	....	....	....	57.8	143	150	143	2.90
667	134	33.00	2.55	....	....	....	57.0	132	140	133	3.14
668	134	34.91	2.87	3.3	....	....	52.6	153	180	154	9.4
669	134	38.76	2.57	....	....	....	45.6	145	158	150	5.06
670	134	37.76	2.65	....	....	....	52.0	152	160	173	3.02
671	135	33.81	2.98	....	....	....	58.7	160	184	178	8.1
*673	135	37.21	2.87	4.8	6.4	....	52.5	163	181	....	6.30
672	135	44.54	3.49	....	....	....	29.3	201	229	215	8.0
673	135	37.60	2.70	....	....	....	49.0	151	166	161	5.56
674	135	36.89	2.89	....	....	....	41.0	150	170	161	6.91
675	135	35.50	2.79	4.9	6.2	....	56.5	155	178	171	8.3
676	135	37.95	2.40	....	....	....	46.0	133	142	136	3.75
677	135	32.58	2.55	16.9	11.6	....	65.0	137	156	151	7.46
678	135	36.10	2.43	....	....	....	63.0	143	160	153	7.00
679	135	37.30	2.67	18.0	12.2	....	38.5	138	143	139	1.87
680	135	37.40	2.67	....	....	....	58.0	158	177	166	7.12
681	136	35.69	2.96	19.5	11.1	....	55.4	164	171	165	2.36
*689	136	36.21	3.04	6.5	8.0	....	66.3	183	202	....	6.25
682	136	37.29	2.72	5.2	10.0	....	48.0	150	170	165	7.36
683	136	38.80	2.74	....	....	....	52.5	162	177	172	5.48
684	136	35.10	2.79	....	....	....	59.4	156	184	177	10.0
685	136	34.70	2.31	....	....	....	52.1	122	140	135	7.8
686	136	38.80	3.01	....	....	....	45.5	170	198	193	9.3
687	136	36.29	2.74	....	....	....	63.0	162	172	169	3.65
688	136	38.71	3.18	....	....	....	36.5	168	184	180	5.03
689	136	37.89	2.69	....	....	....	57.0	160	165	157	1.86
690	136	36.61	3.15	13.0	11.4	....	53.5	177	191	185	4.45
691	137	37.88	2.92	9.7	8.2	....	44.0	159	184	176	8.6
*697	137	39.30	2.38	....	....	....	43.4	134	148	....	5.86
692	137	37.03	2.67	....	....	....	46.6	145	170	160	9.4
693	137	39.03	2.45	....	....	....	44.4	138	147	141	3.67
694	137	38.10	2.30	....	....	....	39.4	122	145	139	10.0
695	137	38.50	2.62	....	....	....	48.0	149	172	161	8.8
696	137	38.99	2.82	7.5	7.0	....	56.5	172	186	181	4.96
697	137	36.79	2.67	....	....	....	52.0	149	176	158	10.1
698	137	35.08	2.60	10.0	25.0	....	48.0	135	150	142	5.76
699	137	40.11	2.48	....	....	....	48.7	148	154	148	2.42
700	137	35.71	2.55	10.8	12.5	....	59.5	145	157	....	4.70

TWO-MOVEMENT ZINC CHLORID AND CREOSOTE[1]—RED OAK.

801	81	39.00	2.55	....	....	....	35.0	134	172	150	14.9
*801	81	34.18	2.43	....	....	....	39.7	116	154	....	15.4
802	81	34.61	2.47	....	....	....	42.6	122	158	....	14.6
803	81	37.20	2.43	....	....	....	45.0	131	163	145	13.2
804	81	37.68	2.48	10.5	10.0	....	41.4	132	166	151	13.7
805	81	36.99	3.38	....	....	....	29.0	161	218	198	16.9
806	81	38.21	3.03	....	....	....	31.0	152	196	176	14.5
807	81	36.34	2.57	10.0	11.0	....	33.8	125	168	154	16.7
808	81	36.05	2.91	6.8	10.5	....	31.4	138	192	174	18.5
809	81	35.86	2.98	....	....	....	49.8	160	190	173	10.1
810	81	36.45	2.96	7.0	8.0	....	18.5	128	199	181	23.9
811	82	36.09	2.62	....	....	....	30.4	123	171	145	18.3
*812	82	34.71	2.40	....	....	....	38.0	115	155	....	16.6
812	82	36.01	2.24	....	....	....	43.9	116	148	126	14.3
813	82	35.20	2.60	10.5	13.7	....	45.2	133	179	154	17.7
814	82	37.19	2.13	....	....	....	45.2	115	141	125	12.2
815	82	40.30	3.13	....	....	....	25.3	158	212	186	17.3
816	82	37.13	2.55	6.3	5.5	....	42.8	135	172	145	14.5
817	82	36.20	2.30	12.8	11.0	....	42.9	119	152	131	14.4

* Sawed for penetration determinations, and therefore not laid in track.
[1] Absorption 3 per cent $ZnCl_2$ solution + creosote.

TABLE 7.—*General records on the individual ties*—Continued.

TWO-MOVEMENT ZINC CHLORID AND CREOSOTE—RED OAK—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
818	82	37.60	2.30	....	....	....	45.6	126	157	137	13.5
819	82	35.26	3.49	....	....	....	39.0	171	238	205	19.2
820	82	36.56	2.69	6.6	10.0	....	40.4	138	176	150	14.1
821	83	35.61	2.45	....	....	....	48.0	129	159	145	12.3
*829	83	35.85	2.96	8.8	10.0	....	39.4	148	188	....	13.5
822	83	37.73	2.41	6.4	4.7	....	43.0	130	153	139	9.5
823	83	34.40	2.81	....	....	....	37.5	133	177	157	15.7
824	83	37.72	2.84	....	....	....	44.6	155	183	165	9.9
825	83	31.98	3.06	....	....	....	40.0	137	189	176	17.0
826	83	35.10	3.49	....	....	....	39.5	171	226	205	15.8
827	83	36.51	2.58	6.6	7.1	....	46.5	138	167	147	11.2
828	83	35.53	2.86	....	....	....	38.7	141	183	162	14.7
829	83	42.00	2.87	....	....	....	34.4	162	192	172	10.5
830	83	....	2.72	8.4	9.0	....	....	146	179	157	12.1
831	84	37.95	2.72	....	....	....	51.0	156	195	170	14.5
*836	84	34.30	3.62	....	....	....	56.2	194	245	....	14.2
832	84	34.80	3.55	....	....	....	41.6	175	244	212	19.4
833	84	....	2.19	....	....	....	....	126	153	136	12.4
834	84	38.50	2.58	....	....	....	43.0	142	179	160	14.3
835	84	39.11	3.43	9.3	9.0	....	41.6	190	219	197	8.5
836	84	35.88	2.77	....	....	....	47.0	146	188	166	15.2
837	84	34.94	3.38	6.9	8.0	....	56.6	185	226	198	12.1
838	84	36.16	2.53	....	....	....	43.2	131	173	153	16.6
839	84	38.60	2.52	5.5	7.4	....	46.0	142	177	153	13.9
840	84	35.80	2.55	9.5	11.4	....	41.4	129	173	151	17.3
841	85	33.52	2.06	24.4	18.2	....	40.4	97	124	109	13.1
*843	85	36.80	2.81	....	....	....	41.3	146	188	....	15.0
842	85	40.02	2.92	....	....	....	37.8	161	196	177	12.0
843	85	38.31	3.03	....	....	....	42.0	165	226	177	20.0
844	85	34.08	2.84	13.7	10.0	....	42.6	138	186	162	16.9
845	85	35.80	2.60	....	....	....	46.2	136	170	151	13.0
846	85	37.20	2.55	....	....	....	37.2	130	166	148	14.1
847	85	37.21	2.55	....	....	....	36.0	129	178	148	19.2
848	85	38.02	2.67	7.3	9.8	....	30.0	132	169	161	13.8
849	85	37.85	3.40	7.1	10.7	....	51.4	195	232	209	10.9
850	85	36.59	2.21	....	....	....	44.7	117	149	133	14.5
851	86	38.53	3.11	....	....	....	41.7	170	218	194	15.4
*856	86	38.34	2.91	8.7	9.2	....	22.0	136	191	....	18.9
852	86	34.51	3.40	....	....	....	29.5	152	230	197	23.0
853	86	36.09	2.65	....	....	....	31.0	125	182	153	21.5
854	86	39.06	2.60	15.3	14.9	....	33.0	135	178	153	16.5
855	86	36.62	2.36	....	....	....	46.0	126	162	142	15.2
856	86	36.02	2.77	....	....	....	36.4	136	190	164	19.5
857	86	36.96	2.87	....	....	....	28.2	136	187	161	17.8
858	86	36.34	3.13	16.3	9.0	....	30.0	148	210	178	19.8
859	86	36.65	2.60	....	....	....	36.5	130	174	151	16.1
860	86	39.91	3.04	7.1	12.0	....	31.7	160	217	188	18.7
861	87	34.79	3.35	....	....	....	63.0	190	230	208	11.9
*863	87	36.48	3.47	....	....	....	45.2	184	228	....	12.7
862	87	36.28	3.47	10.2	9.4	....	57.2	198	238	209	11.5
863	87	39.35	2.82	....	....	....	40.5	156	198	172	14.9
864	87	35.62	2.91	17.6	10.0	....	49.7	155	192	173	12.7
865	87	38.60	2.84	7.0	10.3	....	52.3	167	194	178	9.5
866	87	34.00	2.67	....	....	....	43.2	130	172	154	15.7
867	87	40.13	3.18	8.0	8.0	....	39.5	178	220	196	13.2
868	87	36.78	2.67	....	....	....	46.7	144	178	160	12.7
869	87	39.51	2.28	....	....	....	42.0	128	154	140	11.4
870	87	34.95	2.75	....	....	....	52.0	146	184	161	13.8
871	89	34.88	2.41	....	....	....	42.8	120	161	145	17.0
*878	89	34.89	3.18	....	....	....	44.4	160	216	....	17.6
872	89	37.03	2.58	....	....	....	44.5	138	173	161	13.6
873	89	35.80	2.41	5.6	7.5	....	29.8	112	160	147	19.9
874	89	35.40	3.52	....	....	....	38.0	172	236	209	18.2
875	89	36.71	3.40	....	....	....	30.6	163	224	209	17.9
876	89	35.97	3.47	....	....	....	39.5	174	237	212	18.1
877	89	34.99	3.06	10.2	8.7	....	44.8	155	205	185	16.3
878	89	37.30	3.73	....	....	....	43.0	199	256	233	15.3
879	89	36.80	3.20	7.9	10.0	....	35.0	159	216	193	17.8
880	89	36.27	2.58	6.2	5.5	....	42.1	133	174	153	15.9

* Sawed for penetration determinations, and therefore not laid in track.

TABLE 7.—*General records on the individual ties*—Continued.

TWO-MOVEMENT ZINC CHLORID AND CREOSOTE—RED OAK—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Average number of annual rings per inch in— Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Weight of tie. Directly after treatment.	Weight of tie. Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
881	88	36.49	2.87	....	....	....	54.8	162	208	172	16.0
*885	88	34.80	2.91	8.7	10.0	....	50.0	152	199	....	16.1
882	88	38.50	2.86	....	....	....	32.5	146	182	175	12.6
883	88	37.11	3.26	....	....	....	42.0	172	226	197	16.6
884	88	33.83	3.40	16.7	15.9	....	58.0	182	228	119	13.5
885	88	36.63	2.75	....	....	....	46.9	148	194	168	16.7
886	88	36.61	3.43	....	....	....	51.0	190	248	219	16.9
887	88	37.90	3.45	....	....	....	54.5	202	239	215	10.7
888	88	35.61	2.98	9.8	13.1	....	40.5	149	206	178	19.1
889	88	36.66	3.18	....	....	....	41.5	165	218	195	16.7
890	88	30.50	3.51	7.5	11.0	....	43.7	154	229	186	21.4
891	90	36.40	2.79	....	....	....	37.7	140	187	168	16.8
*894	90	36.77	2.77	7.2	9.0	....	40.5	143	187	....	15.9
892	90	37.25	3.08	....	....	....	45.5	167	210	187	14.0
893	90	34.12	3.01	....	....	....	48.0	152	196	175	14.6
894	90	33.33	2.82	....	....	....	42.7	134	184	164	17.7
895	90	36.15	3.94	7.6	7.0	....	39.5	199	267	136	17.3
896	90	34.70	3.21	....	....	....	42.0	158	210	189	16.2
897	90	36.71	3.20	16.6	10.7	....	42.0	167	215	195	15.0
898	90	34.57	3.47	....	....	....	41.7	170	229	203	17.0
899	90	37.71	2.70	....	....	....	36.5	139	169	153	11.1
900	90	35.32	2.67	13.1	9.6	....	43.0	135	175	151	15.0

TWO-MOVEMENT ZINC CHLORID AND CREOSOTE—MAPLE.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Average number of annual rings per inch in— Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Weight of tie. Directly after treatment.	Weight of tie. Before laying in track.	Absorption per cubic foot.
1001	91	35.07	2.55	....	....	62.7	33.2	119	157	140	14.9
*1003	91	38.56	2.45	....	....	45.0	27.2	120	148	....	11.4
1002	91	36.00	2.36	....	....	71.2	27.1	108	150	130	17.8
1003	91	34.57	2.79	16.4	14.8	77.5	29.6	125	176	160	18.3
1004	91	34.03	2.47	14.2	18.8	71.9	30.9	110	149	125	15.8
1005	91	37.29	3.08	....	....	69.4	25.4	144	195	178	16.5
1006	91	34.00	2.79	21.8	27.7	20.2	28.6	122	148	132	9.3
1007	91	37.64	....	....	....	....	....	179	218	191	....
1008	91	33.40	3.55	....	....	32.2	34.1	159	196	173	10.4
1009	91	36.70	2.82	21.3	18.0	58.2	27.5	132	176	153	15.6
1010	91	....	....	....	....	....	....	149	194	165	....
1011	92	34.77	3.06	....	....	70.2	27.0	135	202	165	21.8
*1016	92	37.67	3.23	....	....	66.6	35.0	164	220	....	17.3
1012	92	33.83	3.09	....	....	58.0	29.1	135	198	160	20.4
1013	92	36.52	2.70	....	....	68.2	28.8	127	182	156	20.4
1014	92	....	....	....	....	....	....	134	170	140	....
1015	92	29.20	3.20	....	....	57.7	35.0	126	154	134	8.8
1016	92	38.45	2.82	35.8	21.2	63.3	27.3	138	192	165	19.2
1017	92	33.48	2.77	17.1	14.8	....	46.8	136	209	155	26.3
1018	92	34.64	2.50	9.1	16.1	58.5	20.2	104	123	120	7.6
1019	92	36.18	3.21	12.8	16.6	50.0	34.4	156	215	180	18.4
1020	92	33.70	3.35	....	....	37.0	29.1	146	197	159	15.2
1021	93	35.20	2.79	....	....	84.2	33.3	130	180	154	17.9
*1021	93	35.53	2.43	....	....	75.6	25.0	108	149	....	16.9
1022	93	30.70	2.99	....	....	40.0	36.2	125	178	165	17.7
1023	93	36.31	3.23	....	....	45.7	35.6	159	198	171	12.1
1024	93	35.53	3.06	26.0	17.7	80.8	30.5	142	202	178	19.6
1025	93	32.00	2.99	....	....	75.0	36.0	130	191	161	20.4
1026	93	32.67	2.77	18.0	17.7	45.7	28.1	116	163	137	17.0
1027	93	36.70	2.50	....	....	....	22.0	112	157	132	18.0
1028	93	36.80	2.48	26.3	22.0	61.0	31.5	120	154	132	13.7
1029	93	35.77	2.57	20.3	26.4	61.7	32.6	122	168	145	17.9
1030	93	33.70	2.98	....	....	78.6	29.5	130	190	157	20.1
1031	94	35.98	2.86	46.8	19.9	34.8	31.2	135	160	147	8.7
*1034	94	37.36	3.23	....	....	75.0	30.2	157	210	....	16.4
1032	94	33.40	2.62	....	....	51.2	31.5	115	164	145	18.6
1033	94	35.46	2.91	....	....	76.0	31.0	135	200	165	22.3
1034	94	33.54	3.01	....	....	53.6	26.7	128	182	151	18.0
1035	94	38.50	3.44	23.2	4.5	85.2	25.2	166	232	193	19.2
1036	94	35.41	3.13	....	....	45.0	30.0	144	194	173	16.0
1037	94	34.35	2.41	24.0	12.2	....	30.5	108	138	117	12.4
1038	94	36.20	3.33	....	....	....	33.6	161	218	192	17.1

* Sawed for penetration det erminations, and therefore not laid in track.

TABLE 7.—*General records on the individual ties*—Continued.

TWO-MOVEMENT ZINC CHLORID AND CREOSOTE—MAPLE—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1039	94	32.23	2.53	....	....	62.6	24.0	101	146	117	17.8
1040	94	30.38	3.45	16.7	32.8	37.5	29.8	136	166	143	8.7
1041	95	34.53	3.15	....	....	76.1	36.0	148	206	176	18.4
*1049	95	34.88	2.92	21.5	24.4	50.0	35.5	138	186	....	16.5
1042	95	31.59	3.01	17.8	24.7	....	36.5	142	188	165	15.3
1043	95	32.94	3.13	....	....	60.0	37.8	142	179	158	11.8
1044	95	....	3.03	28.1	15.2	....	....	142	199	169	18.8
1045	95	35.50	3.23	26.9	18.8	47.9	32.5	152	200	171	14.9
1046	95	35.60	3.25	....	....	....	33.0	154	210	177	17.2
1047	95	33.38	2.98	....	....	55.0	34.8	134	182	151	16.1
1048	95	37.12	2.48	....	....	52.3	39.0	128	162	134	13.7
1049	95	37.09	3.09	....	....	60.0	27.5	146	202	174	18.1
1050	95	34.90	3.38	....	....	80.3	35.5	160	224	188	18.9
1051	96	36.55	2.74	....	....	....	49.8	150	204	179	19.4
*1055	96	36.96	2.75	....	....	....	31.7	134	176	....	15.3
1052	96	30.85	3.42	....	....	....	26.0	133	170	147	10.8
1053	36	30.20	2.87	....	....	60.0	32.7	115	152	137	12.9
1054	96	34.96	4.42	....	....	73.0	32.0	204	274	234	15.8
1055	96	35.75	3.72	35.6	16.6	53.5	32.4	176	216	189	10.8
1056	96	33.50	3.18	....	....	....	33.2	142	178	154	11.3
1057	96	39.49	3.59	20.0	12.3	84.0	27.0	180	228	198	13.4
1058	96	30.50	3.47	17.4	42.9	47.8	30.4	138	164	145	7.5
1059	96	40.26	3.09	....	....	....	25.4	156	206	173	16.2
1060	96	34.99	3.13	21.5	15.2	72.0	28.0	140	198	168	18.5
1061	97	36.15	3.28	....	....	....	30.0	154	206	174	15.8
*1067	97	39.10	3.43	....	....	....	20.0	161	214	....	15.4
1062	97	35.35	3.75	22.3	21.0	....	32.7	176	226	194	13.3
1063	97	35.18	3.32	....	....	64.7	30.2	152	208	175	16.8
1064	97	35.40	4.37	18.1	10.0	....	29.1	200	270	234	16.0
1065	97	38.32	3.38	....	....	83.2	31.3	170	224	191	16.0
1066	97	36.68	3.16	....	....	....	32.0	153	192	171	12.3
1067	97	33.27	2.87	....	....	81.0	34.2	128	180	144	18.1
1068	97	29.13	2.99	7.6	20.0	....	26.4	110	132	119	7.4
1069	97	30.30	3.08	20.9	20.4	....	30.7	122	166	138	14.3
1070	97	35.70	3.01	....	....	78.4	32.0	142	198	157	18.6
1071	98	35.31	3.84	29.1	28.7	64.1	35.5	184	240	209	14.6
*1072	98	34.82	3.51	....	....	72.6	35.7	166	228	....	17.7
1072	98	31.46	2.60	....	....	60.6	44.4	118	170	143	20.0
1073	98	34.75	3.51	27.3	14.0	65.0	34.3	164	232	182	19.4
1074	98	36.37	3.54	....	....	68.2	35.0	174	236	191	17.5
1075	98	33.26	3.20	17.0	27.4	58.7	39.0	148	200	170	16.2
1076	98	36.15	3.60	20.0	14.0	....	33.7	174	234	194	16.6
1077	98	37.08	3.35	....	....	68.7	37.0	170	226	186	16.7
1078	98	34.23	3.50	....	....	81.1	33.6	160	232	190	20.6
1079	98	35.58	3.78	....	....	81.4	34.0	180	256	219	20.1
1080	98	32.28	3.42	....	....	....	34.0	148	202	167	15.8
1081	99	36.20	2.99	....	....	60.0	33.0	144	187	159	14.4
*1089	99	31.65	2.75	....	....	....	31.0	114	148	....	12.4
1082	99	37.10	3.25	....	....	81.8	34.3	162	209	179	14.5
1083	99	31.20	2.92	....	....	....	31.8	120	158	136	13.0
1084	99	37.00	3.16	....	....	....	36.8	160	184	171	7.6
1085	99	35.00	3.11	17.0	22.7	62.2	32.4	144	186	155	13.5
1086	99	35.76	2.50	17.9	25.0	42.9	29.8	116	150	129	13.6
1087	99	27.53	2.57	....	....	81.6	30.0	92	132	98	15.6
1088	99	38.10	3.37	....	....	72.0	32.5	170	214	186	13.0
1089	99	34.94	2.87	11.4	19.7	41.3	27.5	128	156	138	9.8
1090	99	34.50	2.77	12.6	17.3	48.6	27.8	122	150	129	10.1
1091	100	33.05	2.52	....	....	54.6	29.7	108	153	117	17.8
*1100	100	37.35	3.08	28.2	26.0	50.0	27.0	146	198	....	16.9
1092	100	35.27	2.86	....	....	....	28.9	130	183	145	18.5
1093	100	35.33	3.80	19.5	14.2	79.7	40.0	188	258	199	18.4
1094	100	36.30	3.45	....	....	84.1	27.7	160	226	174	19.1
1095	100	33.86	2.98	15.3	13.3	82.1	35.6	137	196	144	19.8
1096	100	34.16	3.23	....	....	47.1	33.0	147	186	155	12.1
1097	100	36.40	2.94	....	....	52.0	30.7	140	182	155	14.3
1098	100	34.07	2.91	....	....	29.8	19.0	118	158	131	13.7
1099	100	26.30	2.75	....	....	63.6	32.8	96	134	103	13.8
1100	100	36.30	2.96	....	....	....	32.1	142	200	162	19.6

* Sawed for penetration determinations, and therefore not laid in track.

TABLE 7.—*General records on the individual ties*—Continued.

CARD[1]—MAPLE.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Average number of annual rings per inch in— Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Weight of tie. Directly after treatment.	Weight of tie. Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1101	112	37.22	2.67	28.0	25.1	32.4	34.8	134	158	142	9.0
*1103	112	34.60	2.41				27.1	106	140		14.1
1102	112	37.19	2.79			39.0	31.1	136	174	151	13.6
1103	112	33.18	3.08				37.0	140	195	165	17.9
1104	112	36.98	2.82	31.0	26.4	63.6	30.4	136	176	148	14.2
1105	112	37.30	2.47			33.3	39.0	128	142	128	5.65
1106	112	35.72	2.96				32.4	140	160	148	6.80
1107	112	31.89	2.40	15.2	11.7	58.0	28.0	98	148	121	20.8
1108	112	34.63	3.30			66.6	36.5	156	224	178	20.6
1109	112	35.91	3.23			72.4	31.0	152	210	173	18.0
1110	112	34.23	2.52	20.8	30.0	30.0	25.2	108	129	117	8.4
1111	113	35.83	2.77			54.4	25.0	124	177	161	19.2
*1117	113	34.66	3.55	30.0	19.7	64.4	33.4	164	224		16.9
1112	113	33.74	3.06			60.0	29.8	134	176	159	13.7
1113	113	34.50	2.93			36.5	28.6	130	178	160	16.4
1114	113	38.06	3.18			52.1	27.2	154	210	180	17.6
1115	113	32.04	3.24	19.3	15.6	64.8	27.1	132	190	175	17.9
1116	113	35.00	2.52			30.0	29.3	114	150	133	14.3
1117	113	32.10	2.84	16.1	17.2		22.9	112	152	129	14.1
1118	113	35.05	2.89				28.4	130	192	163	21.1
1119	113	27.78	3.18	23.6	22.0		22.2	108	174	149	20.7
1120	113	36.75	3.11			37.0	33.0	152	188	174	11.6
1121	114	37.29	2.67			77.8	27.6	127	173	164	17.2
*1130	114	35.38	3.03	26.1	24.5	25.0	34.4	144	188		14.5
1122	114	35.33	3.04			76.0	34.0	144	194	176	16.5
1123	114	33.84		17.1	33.1			151	190		
1124	114	33.12	3.20			51.9	33.0	141	198	182	17.8
1125	114	38.32	3.40				30.4	170	200	187	8.8
1126	114	30.25	3.03				33.1	122	172	155	16.6
1127	114	36.60	2.55	16.8	21.3	60.5	35.0	126	166	149	15.7
1128	114	36.87	3.15	20.7	20.0	67.4	27.4	148	202	174	17.1
1129	114	37.30	2.82			80.4	33.1	140	187	166	16.7
1130	114	36.56	3.33			62.5	28.1	156	199	179	12.9
1131	115	36.35	3.45				29.2	162	209	193	13.6
*1136	115	36.77	3.26	24.5	25.7		37.6	165	210		13.8
1132	115	36.20	3.37				31.2	160	201	184	12.2
1133	115	36.25	3.43			43.6	39.1	173	207	194	9.9
1134	115	36.07	3.26			41.2	36.1	160	203	184	14.4
1135	115	37.23	2.87			62.7	30.1	139	169	160	10.5
1136	115	35.47	3.52			45.7	34.6	168	217	199	13.9
1137	115	35.40(?)	3.16(?)	28.6	17.1		35.8(?)	152	194	174	13.3
1138	115	37.60	2.87			71.4	31.6	142	175	162	11.5
1139	115	35.50	3.18	17.1	8.6	92.0	36.4	154	201	180	14.8
1140	115	36.08	2.82	25.0	17.7	64.5	35.6	138	170	155	11.4
1141	116	35.05	2.89				35.2	137	177	180	13.8
*1144	116	36.04	2.50	23.8	20.0	85.6	28.7	116	154		15.2
1142	116	35.20	3.01	16.2	23.1		32.1	140	206	181	21.8
1143	116	37.08	2.81	28.0	15.2	62.5	24.8	130	159	146	10.3
1144	116							222	267	245	
1145	116	37.20	3.21			74.5	34.8	161	221	194	18.7
1146	116	36.72	2.91				34.7	144	192	173	16.5
1147	116	31.60	3.06				23.1	119	176	154	18.6
1148	116	35.46	3.70			76.6	33.4	175	236	214	16.5
1149	116	37.40	2.86	23.2	39.0	58.2	32.8	142	181	165	13.6
1150	116	37.65	2.96			59.0	36.4	152	181	162	9.8
1151	117	38.09	3.28	26.1	23.1	70.3	27.2	159	216	184	17.4
*1157	117	40.00	2.94			60.0	31.8	155	200		15.3
1152	117	37.73	2.96			55.3	32.5	148	185	165	12.5
1153	117	34.34	3.32			59.2	31.5	150	214	184	19.3
1154	117	35.86	2.89	21.0	15.5	48.2	35.1	140	180	153	13.8
1155	117	31.56	2.91	13.1	30.0	49.0	35.0	124	181	155	19.6
1156	117	37.58	3.60	30.4	34.5	59.6	36.0	184	231	214	13.0
1157	117	37.40	3.08			63.8	27.6	147	194	167	15.3
1158	117	34.25	3.06			64.4	40.2	147	200	179	17.3
1159	117	30.46	2.65			55.6	23.9	100	150	127	18.9
1160	117	37.46	3.06			79.7	32.6	152	206	171	17.7
1161	118	37.39	3.26	17.7	14.6	90.6	25.5	153	218	200	19.9
*1165	118	36.90	3.31			81.2	33.4	163	216		16.0

* Sawed for penetration determinations, and therefore not laid in track.

[1] Absorption emulsion of 80 parts of 3 per cent $ZnCl_2$ solution and 20 parts of creosote by volume at approximately 70° F.

TABLE 7.—*General records on the individual ties*—Continued.

CARD—MAPLE—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Average number of annual rings per inch in— Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Weight of tie. Directly after treatment.	Weight of tie. Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1162	118	36.85	3.01	....	....	63.4	31.6	146	189	176	14.3
1163	118	34.64	2.99	....	....	....	29.4	134	196	182	20.8
1164	118	31.85	3.08	....	....	72.2	29.5	127	207	166	26.0
1165	118	38.12	2.94	....	....	59.6	30.2	146	187	163	13.9
1166	118	33.03	2.86	....	....	76.0	39.7	132	199	178	23.4
1167	118	36.86	3.01	....	....	37.9	26.1	140	178	156	12.6
1168	118	37.75	2.82	27.0	18.3	78.5	29.6	138	182	155	15.6
1169	118	37.25	2.96	15.0	31.1	48.9	27.0	140	180	163	13.5
1170	118	35.70	2.82	14.8	10.0	....	33.1	134	192	168	20.5
1171	119	34.82	3.44	....	....	....	26.1	151	233	197	23.8
*1178	119	38.94	2.96	47.2	29.9	69.6	25.7	145	191	....	15.5
1172	119	36.70	3.29	24.2	26.3	71.2	38.3	167	230	205	19.1
1173	119	39.72	2.87	....	....	60.0	21.9	139	180	157	14.3
1174	119	37.06	3.08	....	....	84.0	28.7	147	202	167	17.8
1175	119	34.46	3.31	....	....	46.9	32.4	151	194	175	13.0
1176	119	36.45	3.69	24.7	25.7	63.7	33.8	180	228	208	13.0
1177	119	37.60	3.33	....	....	78.2	37.4	172	216	182	13.2
1178	119	33.37	3.21	19.2	9.4	86.3	30.7	140	220	180	25.0
1179	119	34.54	2.86	....	....	76.8	32.5	131	203	173	25.1
1180	119	34.30	3.78	....	....	50.8	35.7	176	230	199	14.3
1181	120	35.23	3.20	23.2	7.0	96.4	27.8	144	220	182	23.7
*1188	120	34.89	3.53	21.8	37.5	40.3	27.5	157	207	....	14.2
1182	120	37.54	3.01	....	....	46.7	30.1	147	180	173	11.0
1183	120	34.23	3.01	33.4	17.5	62.6	27.1	131	196	173	21.6
1184	120	36.60	3.63	....	....	44.1	39.3	185	228	200	11.9
1185	120	36.13	4.09	....	....	58.6	35.3	200	256	227	13.7
1186	120	36.36	2.99	....	....	84.0	23.2	134	200	176	22.1
1187	120	37.28	3.04	....	....	77.8	28.0	145	208	173	20.5
1188	120	37.08	3.46	....	....	54.5	32.5	170	212	185	12.1
1189	120	36.61	3.95	28.5	23.0	66.2	37.0	198	244	215	11.7
1190	120	36.48	3.59	....	....	58.7	26.7	166	227	192	17.0
1191	121	36.35	3.35	....	....	59.3	33.0	162	218	193	16.7
*1195	121	37.04	3.51	....	....	....	29.5	168	226	....	16.5
1192	121	36.05	3.33	....	....	40.0	37.4	165	218	182	15.9
1193	121	30.57	2.81	....	....	55.0	29.2	111	162	132	18.1
1194	121	36.89	2.60	27.3	47.2	69.9	27.2	122	172	140	19.2
1195	121	30.50	2.48	....	....	70.4	28.2	97	162	127	26.1
1196	121	35.75	2.99	....	....	65.3	31.0	140	194	157	18.0
1197	121	35.80	3.65	20.3	16.7	58.0	28.3	168	222	188	14.8
1198	121	36.18	3.06	18.4	23.7	73.5	28.2	142	200	166	19.0
1199	121	34.49	3.16	....	....	55.2	34.0	146	206	170	18.9
1200	121	35.65	2.79	44.7	23.7	71.7	30.7	130	186	150	20.0

CARD[1]—RED OAK.

1201	101	37.29	2.45	7.0	7.7	....	45.6	133	162	151	11.8
*1204	101	41.13	3.50	....	....	....	30.6	188	240	....	14.8
1202	101	36.45	2.77	6.5	7.7	....	47.5	149	190	173	14.8
1203	101	....	....	....	....	....	....	147	130	160	....
1204	101	34.28	2.86	....	....	....	47.9	145	194	172	17.1
1205	101	36.22	2.62	....	....	....	28.6	122	176	154	20.6
1206	101	36.80	2.99	....	....	....	41.7	156	198	175	14.0
1207	101	36.39	2.74	....	....	....	40.5	140	184	160	16.1
1208	101	34.21	2.86	7.3	9.0	....	43.0	140	192	171	18.0
1209	101	32.19	2.87	17.7	16.2	....	38.5	128	186	163	20.0
1210	101	38.41	2.48	....	....	....	56.4	149	169	149	8.1
1211	102	37.11	2.65	....	....	....	38.3	136	174	159	14.3
*1220	102	35.99	2.74	10.0	9.6	....	37.9	136	180	....	16.1
1212	102	36.89	2.23	6.5	7.5	....	38.6	114	142	126	12.5
1213	102	36.29	2.50	8.0	6.5	....	41.1	128	160	145	12.8
1214	102	33.33	2.89	....	....	....	49.6	144	194	174	17.3
1215	102	35.22	2.74	....	....	....	45.1	140	186	166	16.8
1216	102	38.10	3.28	....	....	....	45.1	180	228	206	14.7
1217	102	34.74	3.06	....	....	....	38.2	147	201	179	17.6

* Sawed for penetration determinations, and therefore not laid in track.

[1] Absorption emulsion of 80 parts of 3 per cent $ZnCl_2$ solution and 20 parts of creosote by volume at approximately 70° F.

TABLE 7.—*General records on the individual ties*—Continued.

CARD—RED OAK—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in— Heartwood.	Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Directly after treatment.	Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1218	102	38.98	2.24	....	....	....	39.7	122	151	136	12.9
1219	102	37.21	3.82	....	....	....	30.1	185	252	126	17.5
1220	102	30.65	2.72	9.5	11.0	....	60.6	134	174	156	14.7
1221	103	37.31	2.13	7.0	9.1	....	35.8	108	142	130	16.0
*1223	103	37.74	2.74	15.2	11.6	....	43.1	148	188	....	14.6
1222	103	34.69	3.32	....	....	....	38.9	160	216	195	16.9
1223	103	40.50	2.82	....	....	....	31.3	150	190	165	14.2
1224	103	39.32	2.07	15.0	11.6	....	37.6	112	140	122	13.5
1225	103	36.92	2.36	....	....	....	44.6	126	156	138	12.7
1226	103	37.45	2.58	....	....	....	44.9	140	166	143	10.1
1227	103	34.38	2.41	7.4	12.3	....	42.4	118	150	130	13.2
1228	103	44.64	3.30	....	....	....	27.8	188	236	207	14.5
1229	103	43.55	2.77	....	....	....	22.7	148	182	156	12.3
1230	103	37.91	2.41	....	....	....	29.1	118	160	138	7.4
1231	104	35.34	3.40	9.4	11.2	....	46.5	176	230	208	15.9
*1232	104	35.00	3.28	....	....	....	39.4	160	218	....	17.7
1332	104	36.52	2.47	20.2	6.3	....	37.5	124	154	....	12.1
1233	104	38.21	3.06	....	....	....	41.9	166	212	143	15.0
1234	104	33.41	3.03	....	....	....	32.4	134	206	177	23.8
1235	104	36.21	2.40	....	....	....	40.4	122	164	....	17.5
1236	104	35.76	2.57	....	....	....	45.7	134	176	155	16.3
1237	104	37.89	3.26	6.5	7.8	....	32.8	164	222	193	17.8
1238	104	37.81	2.91	....	....	....	27.3	140	194	170	18.5
1239	104	34.14	3.32	9.0	8.2	....	44.6	164	228	197	19.3
1240	104	35.86	3.03	....	....	....	36.3	148	206	180	19.1
1241	105	36.11	2.41	7.5	8.4	....	40.1	122	152	141	12.4
*1244	105	35.89	2.52	....	....	....	30.4	118	158	....	15.9
1242	105	33.59	2.79	8.2	10.0	....	36.6	128	169	158	14.7
1243	105	37.94	3.54	....	....	....	35.5	182	231	213	13.8
1244	105	36.89	3.38	....	....	....	38.0	172	227	203	16.3
1245	105	35.81	3.21	....	....	....	48.7	171	210	193	12.2
1246	105	35.20	3.26	8.2	9.0	....	43.8	165	208	191	13.2
1247	105	34.69	2.45	8.2	12.1	....	44.7	123	164	144	16.7
1248	105	41.04	3.20	....	....	....	27.1	167	210	188	13.5
1249	105	34.39	2.64	....	....	....	43.3	130	174	155	16.7
1250	105	37.40	2.87	....	....	....	39.8	150	196	176	16.0
1251	106	33.98	3.60	....	....	....	47.0	180	232	214	14.4
*1253	106	38.62	3.60	....	....	....	28.0	178	234	....	15.6
1252	106	36.00	2.64	....	....	....	39.0	132	166	155	12.9
1253	106	36.23	2.92	....	....	....	32.4	140	194	168	18.5
1254	106	36.99	2.72	....	....	....	43.1	144	184	168	14.7
1255	106	34.12	3.08	10.7	13.3	....	48.4	156	202	182	14.9
1256	106	40.31	2.67	6.9	7.2	....	41.2	152	180	164	10.5
1257	106	38.30	3.42	7.6	8.0	....	46.6	192	226	204	10.0
1258	106	37.61	3.64	....	....	....	27.1	174	242	216	18.7
1259	106	36.42	2.55	10.6	11.0	....	33.5	124	172	155	18.8
1260	106	33.52	2.92	....	....	....	49.2	146	184	164	13.0
1261	107	32.53	3.45	17.7	12.0	....	39.0	156	228	208	20.9
*1263	107	34.91	3.28	....	....	....	48.5	170	223	....	16.2
1262	107	38.40	2.89	....	....	....	35.1	150	171	161	7.27
1263	107	32.04	3.11	....	....	....	27.4	127	168	155	13.0
1264	107	35.00	2.70	....	....	....	52.4	144	181	164	13.7
1265	107	34.11	3.11	....	....	....	35.6	144	199	181	17.7
1266	107	34.41	2.41	10.2	12.7	....	39.9	116	159	149	17.8
1267	107	35.72	2.48	....	....	....	30.9	116	167	156	20.6
1268	107	35.60	2.13	10.0	12.2	....	39.8	106	142	128	16.9
1269	107	36.47	2.77	....	....	....	36.6	138	180	164	15.2
1270	107	35.38	2.92	7.2	10.7	....	34.5	139	188	175	16.8
1271	108	36.45	2.55	....	....	....	29.1	120	156	145	14.1
*1275	108	35.15	2.75	10.0	7.6	....	37.5	133	170	....	13.5
1272	108	38.10	3.09	8.7	10.0	....	35.9	160	200	181	12.9
1273	108	37.39	2.79	....	....	....	36.1	142	172	159	10.8
1274	108	38.58	3.49	7.5	6.6	....	35.2	182	220	201	10.9
1275	108	36.71	2.53	....	....	....	37.8	128	166	147	15.0
1276	108	36.09	2.55	....	....	....	38.0	127	157	142	11.8
1277	108	33.60	2.86	....	....	....	40.5	135	171	153	12.6
1278	108	36.76	3.15	14.6	7.6	....	31.2	152	200	175	15.2
1279	108	37.59	3.15	....	....	....	41.1	167	205	187	12.1
1280	108	....	....	....	....	....	....	128	165	148	....
1281	[1]110	35.69	2.31	....	....	....	45.5	[2]120	[3]160	148	17.3

* Sawed for penetration determinations, and therefore not laid in track.
[1] Re-treatment. [2] Weight before first treatment. [3] Weight after final treatment.

TABLE 7.—*General records on the individual ties*—Continued.

CARD—RED OAK—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in—Heartwood.	Average number of annual rings per inch in—Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Weight of tie. Directly after treatment.	Weight of tie. Before laying in track.	Absorption per cubic foot.
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
*1285	[1] 110	39.34	2.31	...	...	...	38.5	[2] 126	[3] 158	...	13.9
1282	[1] 110	38.46	3.15	...	...	...	33.8	[2] 162	[3] 214	195	16.5
1283	[1] 110	33.59	1.94	15.1	20.0	...	59.6	[2] 104	[3] 134	121	15.5
1284	[1] 110	36.18	2.26	...	...	...	49.2	[2] 122	[3] 152	138	13.3
1285	[1] 110	35.56	2.87	...	...	...	61.7	[2] 165	[3] 194	174	10.1
1286	[1] 110	39.79	2.07	8.1	7.4	...	39.6	[2] 115	[3] 138	125	11.1
1287	[1] 110	38.21	3.26	...	...	...	49.4	[2] 186	[3] 230	204	13.5
1288	[1] 110	37.30	2.06	...	...	...	38.0	[2] 106	[3] 142	126	17.5
1289	[1] 110	38.80	2.69	7.1	7.3	...	47.6	[2] 154	[3] 184	167	11.0
1290	[1] 110	33.79	2.04	18.5	20.7	...	53.8	[2] 106	[3] 139	120	15.7
1291	111	37.55	2.84	...	...	...	36.5	146	188	164	14.8
*1292	111	41.94	2.33	...	...	...	24.8	122	164	...	18.0
1292	111	36.30	2.53	...	...	...	39.4	128	178	150	19.8
1293	111	35.94	2.35	17.9	12.7	...	46.7	124	164	138	17.0
1294	111	32.50	2.45	...	...	...	48.2	118	165	135	19.2
1295	111	...	2.94	...	...	...	...	162	207	176	15.3
1296	111	39.67	3.52	...	...	...	46.1	204	250	219	13.1
1297	111	34.48	2.81	...	...	...	36.2	132	196	164	22.8
1298	111	38.00	2.67	8.7	10.0	...	38.0	140	190	165	18.7
1299	111	34.39	3.06	19.7	25.0	...	25.5	132	202	175	22.8
1300	111	36.91	2.60	8.4	8.3	...	31.3	126	180	152	20.8

GAS-HOUSE OIL—MAPLE.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in—Heartwood.	Average number of annual rings per inch in—Sapwood.	Sapwood.	Moisture in tie when treated.	Weight of tie. Directly before treatment.	Weight of tie. Directly after treatment.	Weight of tie. Before laying in track.	Absorption per cubic foot.
1401	126	39.54	3.01	...	...	44.0	32.0	157	190	188	11.0
*1405	126	36.56	3.28	...	...	63.7	30.7	157	200	...	13.1
1402	126	38.60	2.82	...	...	60.0	32.3	144	189	185	16.0
1403	126	37.40	2.84	15.7	12.7	60.0	26.0	134	180	179	19.7
1404	126	41.32	3.76	...	...	36.0	26.2	196	226	221	8.0
1405	126	35.42	3.57	...	...	63.8	32.0	167	220	218	14.9
1406	126	36.72	3.13	...	...	66.7	28.0	147	202	202	17.6
1407	126	36.91	3.18	20.0	20.9	70.0	29.5	152	198	194	14.5
1408	126	36.80	2.64	17.8	22.1	85.0	35.0	131	179	175	18.2
1409	126	35.10	3.76	...	...	65.4	37.1	181	219	215	10.1
1410	126	35.05	3.82	44.6	16.8	...	26.4	169	244	242	19.6
1411	127	36.42	2.48	...	...	51.3	35.0	122	161	157	15.7
*1419	127	38.70	2.41	...	...	48.7	28.8	120	132	...	5.00
1412	127	37.60	2.89	14.6	16.2	43.4	36.0	148	152	153	1.38
1413	127	38.36	2.64	...	...	60.8	26.4	128	141	139	4.94
1414	127	37.72	2.82	...	...	59.1	29.8	138	174	170	12.8
1415	127	35.94	2.70	...	...	59.5	34.0	130	160	159	11.1
1416	127	38.47	2.70	...	...	57.5	36.7	142	151	149	3.33
1417	127	34.38	2.67	...	...	69.5	43.8	132	175	172	16.1
1418	127	38.60	2.36	24.7	23.5	64.8	25.0	114	126	127	5.08
1419	127	32.90	2.69	26.4	26.0	...	28.7	114	136	131	8.2
1420	127	36.80	2.65	12.2	21.2	...	33.3	130	162	158	12.1
1421	128	35.53	2.98	24.8	20.8	...	33.0	141	161	158	6.70
*1430	128	34.58	2.57	...	...	75.6	37.3	122	149	...	10.5
1422	128	36.74	2.77	...	...	52.3	32.7	135	175	170	14.4
1423	128	36.00	2.74	...	...	44.5	35.8	134	163	157	10.6
1424	128	37.20	2.74	...	...	...	29.5	132	163	164	11.3
1425	128	35.34	2.77	...	...	71.7	33.7	131	174	169	15.5
1426	128	35.70	2.84	26.0	17.0	65.4	31.2	133	151	150	6.32
1427	128	35.50	2.67	...	...	50.0	35.7	129	163	158	12.7
1428	128	37.04	2.58	19.0	11.7	50.0	33.0	127	137	134	3.88
1429	128	39.14	2.84	16.2	22.9	20.8	25.9	140	152	149	4.23
1430	128	34.20	2.47	...	...	63.8	42.2	120	158	155	15.4
1431	129	38.75	2.84	...	...	...	32.7	146	162	158	5.62
*1437	129	36.08	3.01	...	...	44.3	32.6	144	177	...	11.0
1432	129	34.24	2.65	...	...	...	39.0	126	154	151	10.6
1433	129	35.95	3.47	...	...	...	29.8	162	208	205	13.3
1434	129	35.90	2.60	...	...	40.5	32.7	124	144	142	7.7
1435	129	38.62	2.84	26.4	17.2	37.8	36.6	150	178	174	9.9
1436	129	35.60	2.52	15.5	16.1	77.7	31.7	118	134	133	6.34
1437	129	35.10	3.72	23.5	25.3	70.7	25.6	164	202	197	10.2
1438	129	34.17	2.99	20.0	18.6	53.3	35.2	138	185	186	15.7

* Sawed for penetration determinations, and therefore not laid in track.
[1] Re-treatment. [2] Weight before first treatment. [3] Weight after final treatment.

TABLE 7.—*General records on the individual ties*—Continued.

GAS-HOUSE OIL—MAPLE—Continued.

Track No.	No. of cylinder charge.	Oven-dry weight per cubic foot.	Volume of tie.	Average number of annual rings per inch in—		Sapwood.	Moisture in tie when treated.	Weight of tie.			Absorption per cubic foot.
				Heartwood.	Sapwood.			Directly before treatment.	Directly after treatment.	Before laying in track.	
		Pounds.	*Cu. ft.*			*Per ct.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1439	129	37.60	2.70	....	....	59.5	38.0	140	178	176	14.1
1440	129	34.75	3.21	....	....	....	61.1	180	234	233	16.8
1441	130	38.01	3.28	....	....	82.4	24.5	155	199	197	13.4
*1446	130	36.00	3.16	....	....	37.7	34.5	153	185	....	10.1
1442	130	35.90	3.15	16.7	17.6	88.6	26.4	143	184	180	13.0
1443	130	36.70	3.15	....	....	46.0	35.0	156	178	174	7.0
1444	130	37.70	3.09	22.0	20.7	62.3	30.5	152	186	185	11.0
1445	130	30.50	3.08	16.7	18.3	42.0	29.9	122	152	150	9.7
1446	140	36.48	4.00	....	....	....	35.6	198	234	232	9.0
1447	130	37.11	2.94	....	....	72.3	32.0	144	179	175	11.9
1448	130	35.75	3.49	23.9	24.8	....	34.0	167	192	188	7.2
1449	130	34.14	3.50	....	....	24.6	37.5	164	194	194	8.6
1450	130	37.59	3.04	....	....	82.0	27.8	146	182	180	11.8
1451	131	33.35	3.28	....	....	....	29.8	142	180	176	11.6
*1456	131	35.70	3.03	....	....	60.5	32.2	143	184	....	13.5
1452	131	36.90	3.93	....	....	69.7	33.6	194	242	237	12.2
1453	131	34.50	2.98	....	....	70.6	26.5	130	177	178	15.8
1454	131	37.30	2.58	26.8	19.9	....	39.2	134	165	160	12.1
1455	131	35.21	2.36	25.5	35.4	....	28.8	107	132	128	10.6
1456	131	35.26	2.53	....	....	83.3	31.0	117	162	160	17.8
1457	131	38.60	2.94	....	....	69.0	28.7	146	185	179	13.3
1458	131	34.38	2.70	18.1	21.6	61.0	29.3	120	165	158	16.7
1459	131	38.89	3.16	....	....	....	25.0	154	200	198	14.5
1460	131	39.25	3.32	43.1	23.0	67.4	32.0	172	216	209	13.2
1461	138	37.25	3.15	....	....	46.4	36.5	160	204	200	14.0
*1468	138	34.37	3.47	28.4	34.1	62.2	38.5	165	216	....	14.7
1462	138	35.85	3.25	....	....	66.7	27.0	148	206	200	17.7
1463	138	34.92	3.79	27.6	27.4	59.2	36.0	180	238	233	15.3
1464	138	36.06	3.32	....	....	69.0	29.5	155	195	193	12.0
1465	138	39.57	3.66	....	....	32.2	29.3	187	218	216	8.5
1466	138	33.72	3.76	16.5	19.4	92.0	34.7	171	255	247	22.3
1467	138	35.80	2.58	....	....	53.8	31.0	121	160	156	15.1
1468	138	36.42	3.35	19.7	12.3	47.1	31.8	161	206	202	13.4
1469	138	37.00	2.99	....	....	65.1	51.0	167	200	197	11.0
1470	138	36.74	3.42	....	....	84.2	27.3	160	222	220	18.1
1471	139	36.52	3.49	....	....	64.0	34.0	171	208	206	10.6
*1475	139	37.32	2.87	....	....	87.0	31.6	141	180	....	13.6
1472	139	34.29	3.42	20.5	24.4	82.0	45.8	171	234	233	18.4
1473	139	40.30	3.32	....	....	51.8	29.4	173	214	210	12.4
1474	139	36.82	3.57	....	....	54.2	28.5	169	214	209	12.6
1475	139	35.18	2.28	....	....	82.0	33.4	107	148	146	18.0
1476	139	30.86	3.61	....	....	....	37.4	153	232	231	21.9
1477	139	34.48	2.75	23.1	28.5	43.9	40.4	133	170	167	13.5
1478	139	35.10	3.45	....	....	66.2	44.6	175	212	209	11.7
1479	139	37.36	2.07	17.2	20.0	75.6	19.0	92	131	126	18.8
1480	139	36.85	2.47	45.9	31.1	61.1	30.8	119	143	142	9.7
1481	140	37.60	2.62	....	....	80.0	33.0	131	174	170	16.4
*1484	140	39.06	2.62	....	....	71.5	32.0	135	171	....	13.8
1482	140	40.70	2.77	22.5	14.6	26.0	32.0	149	180	174	11.2
1483	140	38.94	3.11	....	....	56.5	32.0	160	198	190	12.2
1484	140	38.25	2.84	....	....	79.5	31.6	143	186	182	15.1
1485	140	35.88	3.30	25.7	19.1	78.2	28.5	152	210	209	17.6
1486	140	36.58	3.97	8.1	21.6	67.6	31.0	190	245	241	13.9
1487	140	38.57	3.16	29.6	27.6	69.3	24.0	151	188	181	11.7
1488	140	37.59	3.43	....	....	52.6	35.7	175	225	219	14.5
1489	140	35.23	3.63	....	....	50.6	30.5	167	209	207	11.6
1490	140	36.16	2.86	....	....	66.0	29.6	134	172	165	13.3
1491	141	36.87	3.89	....	....	78.6	36.9	196	254	248	14.9
*1495	141	37.98	3.62	....	....	....	33.1	183	236	....	14.7
1492	141	33.70	3.37	36.2	16.0	87.5	32.0	150	224	215	21.8
1493	141	37.70	3.09	....	....	54.7	35.6	158	196	192	12.3
1494	141	40.30	3.25	....	....	68.7	31.4	172	206	200	10.5
1495	141	36.58	2.82	....	....	37.2	37.6	142	176	174	12.1
1496	141	34.60	3.18	....	....	47.0	32.7	146	183	178	11.6
1497	141	35.70	3.40	28.8	27.3	69.3	32.6	161	217	210	16.5
1498	141	36.10	3.01	13.4	23.8	78.4	30.6	142	194	188	17.4
1409	141	....	....	....	....	....	....	146	182	177	....
1500	141	36.80	2.79	....	....	59.2	32.5	136	174	171	13.7

* Sawed for penetration determinations, and therefore not laid in track.

APPENDIX.

ACCURACY OF THE DETERMINATIONS.

In computing the precision of the determinations the volume of the ties was assumed to be 2.68 cubic feet, which represents their normal size, and the weight 125 pounds, the approximate weight at the time of treatment of a tie of the normal size. However, the greater portion of the ties were larger than this. The magnitude of the error in the determinations, expressed in per cent, decreases as the size and weight of the ties increases, and the size and weight assumed in the computations have, therefore, a tendency to make the computed error greater than the true precision of the determinations for any particular tie.

The scales used were all tested, and errors due to their inaccuracy were found to be inappreciable so far as the results of the experiments are concerned. The maximum inaccuracy of the thermometers over the range of temperatures used was 1° F. The pressure gauge on the treating cylinder had a constant inaccuracy of 3 pounds with the higher pressures, and the vacuum gauge had a maximum inaccuracy of 0.3 inch of mercury. The effect of these errors would be inappreciable on the experimental results, and no corrections were made for them.

TIE VOLUMES.

Errors in the determinations of the volumes of the ties might arise from three causes:

(1) Inaccuracy of the reading of the gauge glass.

(2) Inaccuracy of the calibration of the tank.

(3) Absorption of water by the tie during its immersion.

The gauge glass was graduated to 0.01 and read to 0.005 of a foot; the maximum deviation of any one reading is therefore ± 0.0025 tank-foot. Since the volume of the tank was 1.72 cubic feet for every foot in depth, the maximum deviation amounts to ± 0.0043 cubic foot, or ± 0.16 per cent of the assumed volume of the tie. The volume of the tie depends upon two observations; hence the maximum possible deviation of the results equals $\pm 0.16 \times 2$, or ± 0.32 per cent. The maximum deviation is very unlikely to occur, and the error in reading the gauge glass is most likely to be between ± 0.2 and ± 0.3 per cent.

In the calibration of the tank there was a maximum deviation of ± 0.022 cubic foot for each foot of depth, and since the volume of

the tie (2.68 cubic feet) required 1.56 tank-feet, the maximum possible deviation from this source amounted to ± 0.034 cubic foot, or ± 1.3 per cent.

Except in a very few instances the absorption of water by a tie during its immersion was found to be not more than 0.02 foot on the gauge glass for a tie of 2.68 cubic feet volume. It seems probable that most of this absorption occurred before the reading of the gauge (during the immersion of the tie) was made. Therefore, the difference between the reading of the gauge glass after the tie was removed from the tank and that made during its immersion was taken as the measure of the volume of the tie.[1] Even under the supposition that the rate of absorption of water by the tie during the time of its immersion was uniform, the maximum error could not have been more than $\frac{0.02}{2}$, or 0.01 foot, on the gauge glass. Moreover, it is believed that the interval of time between the reading of the gauge and the removal of the tie from the water was shorter than that between the immersion of the tie and the reading of the gauge. The absorption of an amount of water equal to 0.01 tank-foot between the high and low readings would produce an error in the volume of a tie of $+0.0172$ cubic foot or $+0.63$ per cent.

The maximum deviation of the determination of the tie volumes, considering the several sources of error mentioned, therefore $= \pm 0.3 \pm 1.3 = \pm 1.6$ per cent, added to which is the maximum error due to absorption of water by the tie of $+0.6$ per cent. The maximum deviation is very unlikely to occur, and the error in this determination is most likely to be between ± 1.0 and ± 1.5 per cent, to which must be added the maximum error of $+0.6$ per cent.

OVEN-DRY WEIGHTS.

Errors in the determination of the oven-dry weights in the ties might arise from two causes:

(1) Inaccuracy of the weighings.

(2) Variation in the specific gravity of the wood throughout the tie.

Since the displacement weighings were made to the nearest one-half ounce, the greatest deviation of any one weighing was ± 0.025 ounce. The sections generally displaced 28 ounces, or more, of water. Assuming this weight as a basis for calculation, the maximum percentage deviation due to each weighing was ± 0.89. The determination depended upon two weighings and, therefore, the maximum deviation of the determination equals $\pm 0.89 \times 2 = \pm 1.8$ per cent. The maximum deviation is very unlikely to occur, and the error in this determination is most likely to be between ± 1.0 and ± 1.5 per cent. The weights of the oven-dry sections were made with

[1] The ties were allowed to drip into the tank for a short time after being removed from the water.

such accuracy that no appreciable error was introduced at that point.

The sections for the dry-weight determinations were cut at random from either end of the tie. It is known that the specific gravity of the wood in a tree varies with the height from the ground, but no tests were made to ascertain what this variation was between the two ends of the ties. Determinations made by the Forest Service on a red-oak tree, in connection with strength tests, indicated a mean variation of 2 per cent in the specific gravity between points 8 feet apart. If the same variation existed in the ties an error of ± 1 per cent was introduced by computations of dry weight from sections cut from one end only.

ABSORPTION.[1]

The determination of the absorption of the ties by weights involved four weighings—two just before the ties entered the cylinder and two just after the completion of the treatment. The weights were in each case obtained by differences; i. e., the tram was placed upon the scales and the beam of the scales was balanced before and after a tie had been placed upon or removed from the tram. Weighings on the tramcar scales were made to the nearest pound. Therefore the greatest deviation each time the scales were balanced was ± 0.5 pound. Assuming a tie of 2.68 cubic feet treated with 12 pounds of preservative per cubic foot of wood, this amounts to an error of ± 1.6 per cent. Since the weight of each tie was obtained from a difference of two weighings before and again after treatment, the determination of absorptions required four weighings. The maximum deviation of the determination is, therefore, $\pm 1.6 \times 4 = \pm 6.4$ per cent. The maximum deviation is very unlikely to occur, and the error in this determination is most likely to be between ± 3.0 and ± 4.0 per cent. In the case of the ties which absorbed more than the assumed weight of preservative the error is proportionately less, while for an absorption of 5 pounds of preservative per cubic foot of wood the error in the determinations most likely to occur is probably between 7 and 8 per cent. The most likely error in the measurement of the absorption of a cylinder charge as a whole when determined from a difference of weights of the entire charge is probably between ± 0.25 and ± 0.35 per cent, if an absorption of 12 pounds of preservative per cubic foot of wood is assumed.

It has been claimed that the chief inaccuracy in the determination of the absorption of preservative in timber from weights is caused by a loss of moisture—sap, resins, and other substances—during treatment, so that the absorption of an equal weight of creosote is

[1] In cold or damp weather the ties were piled indoors for a few days before treatment in order to eliminate the effect of ice, snow, or water adhering to the surface.

not detected by the weighing.[1] That any very appreciable interchange of this nature took place in the experiments described in this bulletin seems most unlikely, since the ties (excepting possibly the red-oak ties treated with gas-house oil) were well seasoned before treatment. Also the analyses of the creosote made during the progress of the treatments show that there was approximately the same percentage of water in the creosote in the measuring tank after a large number of treatments had been made as there was in the creosote in the storage tank before any of the treatments were begun.[2]

The error from the dripping and the volatilization of preservative between the time the cylinder door was opened and when all of the weighings had been completed is believed to be negligible. The greater part of the drip was caught in the cylinder and returned to the measuring tank before the cylinder door was opened. Only a slight amount of drip subsequent to this and before the weighings had been completed was noticed.[3]

WEIGHT OF TIES BEFORE PLACEMENT.

Since the scales used in weighing the ties before laying in the track had a precision of 0.5 pound, and only one weighing was necessary, the probable error was evidently inappreciable, as compared with the determinations of weights of the ties directly after treatment. It is, therefore, not necessary to consider it. The same number of significant figures have been retained in each case, however, because of the fact that the weights of the ties before laying in the track are of interest only in connection with the weights taken at the time of treatment.

ERRORS IN MEASUREMENTS BY FLOAT GAUGES.[4]

Although the absorptions recorded in this bulletin are obtained from the weights of the ties before and after treatment, it is believed that a discussion of the inaccuracies inherent in float-gauge measure-

---

[1] Necessarily, the only difference in the weight of the timber from an interchange of equal volumes would be due to the difference in the specific gravities of the substances leaving the wood and the preservative in question at the treating temperature. And this difference is usually small. Likewise, where measuring-tank gauges are relied upon, the greatest difference that could be detected in the readings due to such an interchange would be due to the difference in the specific gravities of the two liquids, which in this case would cause the float to change its position with respect to the surface of the liquid. Also, where temperature corrections of the measuring-tank readings have to be made, a difference in the coefficients of expansion of the two liquids might produce some change in the calculated results. However, in either case the effect on the results would not be noticeable unless the volumes of liquids exchanged were comparatively large. A discussion of the accuracy of float gauges is given elsewhere in the appendix.

[2] See pp. 39-40.

[3] The most noticeable amount of drip occurred after treatments of red-oak ties by the Rueping process. It has been suggested that if the final vacuum had been held for a longer period the dripping of these ties might have been reduced.

[4] The gauge board used in the experiments discussed in this bulletin is shown in figure 1. It is believed that the only material difference between the horizontal gauge here shown and the vertical type in common use is the larger number of pulleys and the longer connecting wire in the horizontal type.

ments will be of value to those interested in the wood-preserving industry. The cause of many of the errors is the different temperature at which various readings of the gauge are made, which affects the volume and density of the preservative fluid, the capacity of the measuring tank, the size of the float, and the length of the gauge wire. Another source of error lies in the inertia of the gauge and the friction of the pulleys. Besides these errors, whose magnitude can be calculated with more or less accuracy, there are other errors, the magnitude of which is not readily determined.

The various errors are illustrated by examples in which the following values are assumed:

Temperature of the preservative at the initial gauge reading in degrees F. = $203° = t$

Temperature of the preservative at the final gauge reading in degrees F. = $165° = t_1$

Specific gravity of the preservative (assumed to be creosote) at temperature t = $1.028 = S_t$

Specific gravity of the preservative at temperature $t_1 = 1.044 = S_1$

Depth of preservative in feet at the initial gauge reading (at temperature t) = $10.45' = L_t$

Depth of preservative in feet at the final gauge reading (at temperature t_1) = $9.56' = L_1$

CHANGE IN VOLUME OF PRESERVATIVE WITH CHANGE IN TEMPERATURE.

Assuming that at the time of reading the gauge the temperature of the preservative is the same throughout the tank, the following equation is used for correcting the volume of the preservative for temperature change:

$$V_t = V_1 \frac{S_1}{S_t} = V_1\left(\frac{1.044}{1.028}\right) = V_1 \ 1.016$$

in which V_t = the volume at temperature t, and V_1 the volume at temperature t_1. The assumed final reading is 9.56 feet, which becomes 9.71 feet when the correction is applied. The error due to expansion of the oil is in this case 0.15 tank-foot, which is equal to 20 per cent of the corrected absorption.[1]

CHANGE IN VOLUME OF MEASURING TANK WITH CHANGE IN TEMPERATURE.

If u represents the area of a cross section of the measuring tank at temperature t, and k the coefficient of expansion,[2] then

$$u\,[1-(t-t_1)\,2k]$$

[1] The change in gravity of creosote with change in temperature is found by the equation $S_t = S_1 + (t - t_1)f$, in which f is a constant with the value 0.00043. For gas oils $f = 0.00036$ (Sir Boverton Redwood, Petroleum and Its Products, 2d ed., p. 208). A table of the specific gravities of zinc-chlorid solutions is given on p. 85.

[2] For wrought iron or mild steel this amounts to 0.00000673 per degree F. per unit length; Mechanical Engineers' Pocketbook, by Wm. Kent, 7th edition, p. 385.

will represent the area at temperature t_1.[1] The heights of a given volume of liquid are in inverse proportion to the corresponding areas of the cross section of the measuring tank. Hence, if L_2 represents the height L_1 corrected for change in temperature of the tank,

$$\frac{u}{u\,[1-(t-t_1)\,2k]}=\frac{L_1}{L_2}$$

or

$$L_2=L_1\,[1-(t-t_1)\,2k]$$

The change in height of a given volume of the preservative due to a change in volume in the tank $=L_2-L_1=L_1\,[1-(t-t_1)\,2k]-L_1=-L_1\,(t-t_1)\,2k$.

By substituting in this equation the values given in the example, $L_2-L_1=-9.56\,(203-165)\,2\times 0.00000673=-0.00489$ tank-foot.

The change in volume of the measuring tank has, therefore, a tendency to make the indicated absorption too small when the temperature is less at the final than at the initial gauge reading. The error in the example given amounts to 0.66 per cent of the absorption.[2]

CHANGE IN POSITION OF FLOAT WITH CHANGE IN ITS VOLUME.

A change in position of the float with respect to the surface of the preservative will be effected by a change in the volume of the float with change in its temperature. Since the displacement is assumed to be constant, the problem may be solved similarly to the preceding one.

Although a part of the submerged portion of the float is conical in form, it may be considered as a cylinder of the same diameter and equivalent volume. Calling p_t the submerged height of the float at temperature t, and p_1 the submerged height at temperature t_1,

$$p_1-p_t=p_t\,(t-t_1)\,2k$$

The float was submerged to approximately the top of the cylindrical portion (fig. 23); therefore,

$$p_t=\left(2+\frac{4}{3}\right)=\frac{10}{3}\text{ inches}=\frac{10}{36}\text{ feet.}$$

Substituting this value and the other values in the example chosen in the equation,

$$p_1-p_t=\frac{10}{36}\,(203-165)\,2\times 0.00000673=0.000142\text{ tank-foot.}$$

The submerged depth of the float is 0.000142 foot less at temperature t than at t_1, on account of its change of size; it accordingly

---

[1] It is assumed that the coefficient of surface expansion with change in temperature is twice that of lineal expansion.

[2] The percentage errors are based on the absorption corrected for differences in the temperature of the preservative, which is the approximate true absorption.

floats higher (i. e., the portion of the float above the surface of the liquid is higher at the higher temperature). The error amounts to 0.02 per cent of the absorption.

CHANGE IN POSITION OF FLOAT WITH CHANGE IN SPECIFIC GRAVITY OF PRESERVATIVE.

When the temperature of the preservative changes from t to t_1, its specific gravity changes from S_t to S_1. Since the effective weight of the float remains the same in both cases, the volume of the preservative displaced must change in order that an equilibrium of forces may be established. The change in the submerged volume of the float is in inverse proportion to the change in specific gravity of the preservative. Calling u the area of cross section of the cylindrical portion of the float, p_1 the effective depth of submersion of the float at temperature t_1, and p_2 the value of p_1 corrected for a specific gravity of the preservative corresponding to the temperature t, then,

$$\frac{p_1 u}{p_2 u} = \frac{S_t}{S_1},$$

$$p_2 = p_1 \frac{S_1}{S_t},$$

and

$$p_1 - p_2 = p_1\left(1 - \frac{S_1}{S_t}\right)$$

Applying the specific example to this equation,

$$p_1 - p_2 = \frac{10}{36}\left(1 - \frac{1.044}{1.028}\right) = -0.00432 \text{ tank-foot.}$$

Because of the decreased specific gravity of the preservative the gauge floats higher in the cooler oil, which in the example given tends to make the indicated absorption too small by an amount equal to 0.59 per cent of the actual absorption.

VARIATION IN LENGTH OF GAUGE WIRE WITH CHANGE OF TEMPERATURE.

The measuring-tank gauges were entirely under cover, in a position not much affected by drafts or changes in temperature of the air. It seems fair, therefore, to assume that the temperature of that portion of the gauge wire which was outside of the tank (i. e., beyond the tank cover) was approximately the same at the beginning and end of any treatment, and, since a very fine wire was used, that the portion of the wire emerging from the tank with a rise of the float reached room temperature before the gauge was read. It also seems probable that at any given time the portion of the wire which was within the tank (i. e., between the float and the tank cover) was at approximately the same temperature as the preservative and vapors

which the tank contained. Under these conditions the change in length of the wire between an initial and a final gauge reading at temperatures t and t_1, respectively, is represented by the equation:

$$h_2 = l_t(t_1 - t)k + (l_1 - l_t) \quad (t_1 - t_2)k$$

in which h_2 equals the change in length of the wire due to the change in temperature from t to t_1, and l_t and l_1 represent the length of wire within the measuring tank at the initial and final gauge readings, respectively,[1] and t_2 the room temperature.

Applying to this equation the values given in the example, $h_2 = 1.55$ $(165-203)\ 0.00000673 + (2.44-1.55)(165-70)0.00000673 = -0.00040$ $+0.00057 = 0.00017$ tank-foot.

When the temperature of the measuring tank fell that portion of the gauge wire within the tank contracted; but since the level of the liquid was lower at the end of the treatment, a portion of the wire was drawn in from the outside, which expanded because of its increased temperature. The total result was a small increase in the length of the wire. This would tend to make the indication of the gauge at the end of the treatment too high and the indicated absorption too low by a corresponding amount. Hence the error, which amounts to 0.02 per cent, is of the negative sign.

POSITION OF INDICATOR AS AFFECTED BY RESISTANCE IN THE GAUGE AND DIFFERENCES IN TENSION IN THE GAUGE WIRE.

In order to make the readings of these measuring-tank gauges as sensitive and as accurate as practicable, they were constructed according to the following principles:

Calling the weight of the float in pounds, W; the resistance of the gauge (which includes the frictional resistance of the pulleys, the resistance of the wire to bending about the pulleys of one gauge, etc.) expressed in pounds, r; the weight of the counterweight in pounds, W; and neglecting the weight of the gauge wire and the effects of differences in surface tension on the float, then,

The upward pull on the float during any period in which the level of the liquid is dropping $= w + r$,

The upward pull on the float during any period in which the level of the liquid is rising $= w - r$,

and

The difference between these two upward forces on the float $= (w+r) - (w-r) = 2r$.

There will, therefore, be two different positions of the float and two corresponding different positions of the float and two corresponding

---

[1] That part of the float which was between the surface of the preservative and the wire is included in l_1 and l_t, since its coefficient of expansion is practically the same as that of the wire. l_t=(12.00−10.45) =1.55 (nearly) l_1=(12.00−9.56)=2.44 (nearly).

positions of the gauge for any given level of liquid in the measuring tank, depending upon whether this level has been rising or falling just previous to the time of reading, the force, $2r$, being a measure of the difference between these positions. Calling d the difference in feet of the height of the float in its two positions for a given level of liquid; A, the area of cross section of the float in square feet; and S, the weight per cubic foot of the liquid at the given temperature at which it is being measured, then,

$$2r = AdS$$

or

$$d = \frac{2r}{SA}$$

S is a constant so far as this discussion is concerned, since it depends entirely upon the particular liquid to be measured and its temperature. It is evident, then, that in order to make the magnitude of the possible error, d, in the gauge readings small, the resistance, r, in the pulleys and wires should be made small, and the area of cross section, A, of the float should be made large. With this end in view, the diameter of the float was made as large as practicable (18 inches), and a fine-gauge piano wire was used to connect the float and the counterweight; the pulleys were of turned brass with large pins to reduce friction (silk gimp and also phosphor-bronze wire were used instead of the piano wire in some of the treatments). The counterweights were just sufficiently heavy to keep the wires taut across the gauge board.

The floats are made of heavy galvanized iron. The pipe shown near the top (fig. 23) is to permit the passage of air to or from the interior with the changes of temperature to which the floats are subjected. The pipes may be removed, and sand, shot, or other material may then be introduced into the floats to give them suitable weight. The bends in the air-relief pipe are to prevent the preservative from spattering through into the interior. The bottoms of the floats are made conical so that the center of gravity of any weighing material which may be placed in them will come to a stable position at the bottom. The floats were weighted sufficiently to sink them as far as the tops of the cylindrical portions when placed in water.

In order to ascertain the magnitude of the error due to the resistance of the gauge, water at approximately 70° Fahrenheit was run into the measuring tank, and after a certain amount of it had been slowly drawn off (in order to have the level of the water falling) a gauge reading was taken. More water was then drawn off and carefully poured back into the measuring tank, without, however, agitating the surface of the water in the tank. The tank then contained the same quantity of water as when the first gauge reading was taken. A second reading was then made. The difference between these

two readings was taken as twice the resistance of the gauge.[1] This error was found from a large number of trials to have an average value of one-eighth inch, or 0.0104 tank-foot. While it might seem that the readings could be corrected for this error from a knowledge of whether the general level of the liquid had been rising or falling just previous to the taking of a given reading, it must be borne in mind that during the treatment the surface of the liquid in the measuring tank was more or less agitated, especially while the preservative was being returned to the tank. On account of this agitation it was im-

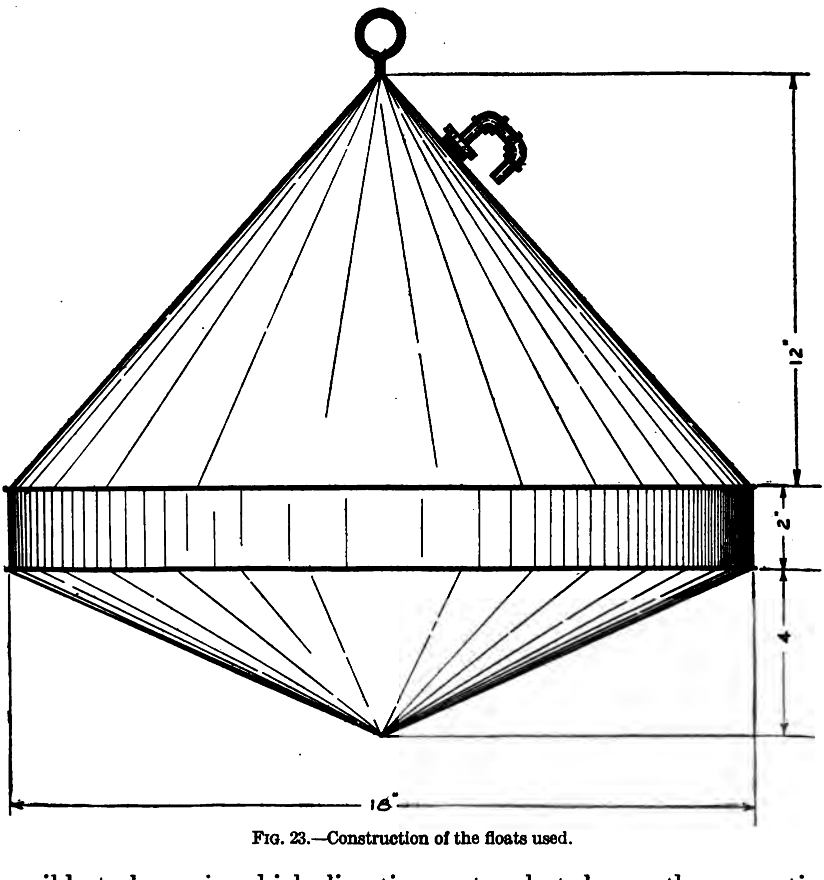


FIG. 23.—Construction of the floats used.

possible to know in which direction or to what degree the correction should be applied. It must, therefore, be treated as an error whose sign is indeterminate. The error amounts to ± 1.4 per cent of the assumed absorption for each reading of the gauge. Since the determination of absorption depends upon two readings, the precision measure of the determination $= \pm 1.4\sqrt{2} = \pm 2.0$ per cent.

[1] This difference also included the change in length of the gauge wire due to differences in tension of the wire between the indicator and the float, but since that length of wire included only about one-half of the length of the gauge wire and one-half of the pulleys, and the difference in tension on either side of a given pulley was very slight, it is believed that this factor may be safely disregarded.

OTHER ERRORS.

Since the entire gauge was under cover, the effect of wind pressure on the wire was eliminated, and, because of its very slight total weight, the varying weight of wire on either side of the pulley system was obviously inappreciable. Moreover, the weight of the pointer produced a hardly perceptible sag in the gauge wire, and its effect may also be eliminated in so far as it might have produced an appreciable error in the results. Especial care was always taken to see that the gauge wire moved freely, so that there was little chance of that part which was between the float and the first pulley having been inclined to the vertical.

The manner in which the treatments were conducted leaves little chance for the loss or the pocketing of preservative during treatment.

A lack of uniformity in the temperature of the preservative in the measuring tank would affect both the original readings and their corrections, but a study of such variations was not practicable at the time the experiments were made.

The error due to volatilization from the measuring tanks was found to be inappreciable during the treatment of any given charge.

There is some reason to believe that by blowing back the preservative from the receiving to the measuring tanks by compressed air some air may have been entrained, especially since a certain amount of water was present in the preservative and the latter passed from the outlet of the pipe at the top of the measuring tank to the surface of the liquid in the tank as more or less of a spray. The difficulty of eliminating even a slight amount of entrained air from a liquid is well known, and a comparatively small amount of it would probably have affected the gauge readings considerably. Assuming that the amount of entrained air in the preservative remained the same at both the initial and the final gauge readings, the rate of change in volume of the air with change in temperature, being considerably greater than that of the liquids, may have produced considerable error in the gauge readings. On the other hand, a rise in temperature of preservative containing entrained air would possibly have caused the freeing of some portion of the air. It was found that in those treatments in which there seemed to be the most likelihood of air having been entrained in the preservative the disagreement between amount of absorption as determined by gauge readings and by weighings was most marked.

It is possible that there may have been other errors in the measurement of absorption by tank gauges which are not at this time realized.

SUMMARY.

Omitting the error due to change of temperature of the preservative, for which the correction has been applied, errors of the magnitude

given below are found in float-gauge determinations under the conditions given:

	Per cent.
Due to change in temperature of the measuring tank	−0. 66
Due to change in temperature of the float	+0. 02
Due to change in specific gravity of the preservative as affecting the position of the float	−0. 59
Due to change in temperature of the gauge wire	−0. 02
Total determinate error	−1. 25

We thus have a determinate error of −1.3 per cent for which a correction might be applied, but this is less than the precision measure of the result (due to the resistance of the gauge) which equals ±2.0 per cent.

In addition to the calculated errors, there may be considerable variation due to lack of uniformity in the temperature of the measuring tank at any given time, the presence of entrained air in the preservative, or other causes as yet undiscovered.

ANALYSES OF PRESERVATIVES.

CREOSOTE.

The creosote used in the treatments described in this bulletin was taken from a single tank-car shipment. One sample was taken from the storage tank before any of the treatments were made; another sample was taken after the completion of the first two processes using creosote, in order to detect any change that might have taken place in the composition of the creosote as its volume was diminished by use. For comparison a sample was taken also from the storage tank. The first sample was analyzed by the Forest Service laboratory method; the two other samples were analyzed by the Forest Service field method.

The results of these analyses are as follows:

SAMPLE OF CREOSOTE TAKEN FROM STORAGE TANK BEFORE TREATMENTS WERE BEGUN (SAMPLE A).

Date of analysis, December 12, 1910.
Specific gravity at 60° C. (by picnometer), 1.0483.
Viscosity (by Engler viscosimeter):

At 98° C	1. 13
At 76° C	1. 23
At 58° C	1. 34
At 24° C	2. 03
At 9° C	3. 24

Flash point, 93° C.
Burning point, 100° C.
Character, liquid.

TABLE 8.—*Distillation record of creosote sample A (Forest Service laboratory method, with Hempel flask).*

No.	Temperature.	Distillate.			Index of refraction at 60° C.
		Observed.	Water-free.	Cumulative.	
	° C.	Per cent.	Per cent.	Per cent.	
1	180	12.8	4.8	4.8	....
2	205	5.7	6.2	11.0	....
3	215	6.2	6.8	17.8	....
4	225	12.5	13.6	31.4	....
5	235	7.2	7.9	39.3	1.5889
6	245	4.7	5.1	44.4	1.5905
7	255	2.3	2.5	46.9	1.5918
8	265	3.7	4.0	50.9	1.5931
9	275	2.9	3.2	54.1	1.5960
10	285	3.2	3.5	57.6	1.6010
11	295	4.7	5.1	62.7	1.6066
12	305	4.1	4.5	67.2	1.6107
13	320	6.3	6.9	74.1	....
Residue	....	23.6	25.8	99.9	....

SAMPLE OF CREOSOTE TAKEN FROM STORAGE TANK AFTER COMPLETION OF FIRST TWO CREOSOTE PROCESSES (SAMPLE B).

Date of analysis, May 9, 1911.

Specific gravity at 60° C. (by hydrometer), 1.044.

Character, liquid.

TABLE 9.—*Distillation record of creosote sample B (Forest Service field method, with common flask).*

No.	Temperature.	Distillate.		
		Observed.	Water-free.	Cumulative.
	° C.	Per cent.	Per cent.	Per cent.
1	205	12.4	10.2	10.2
2	235	23.0	23.6	33.8
3	255	14.2	14.5	48.3
4	270	8.8	9.0	57.3
5	295	11.0	11.2	68.5
6	320	8.5	8.7	77.2
Residue (by difference)	....	22.1	22.8	100.0

SAMPLE OF CREOSOTE TAKEN FROM MEASURING TANK AFTER COMPLETION OF FIRST TWO CREOSOTE PROCESSES (SAMPLE C).

Date of analysis, May 9, 1911.

Specific gravity at 60° C. (by hydrometer), 1.055.

Character, liquid.

TABLE 10.—*Distillation record of creosote sample C (Forest Service field method, with common flask).*

No.	Temperature.	Distillate.		
		Observed.	Water-free.	Cumulative.
	° C.	Per cent.	Per cent.	Per cent.
1	205	8.0	0.0	....
2	235	15.6	17.0	17.0
3	255	15.2	16.5	33.5
4	270	9.2	10.0	43.5
5	295	8.1	8.8	52.3
6	320	11.0	11.9	64.2
Residue (by difference)	....	32.9	35.8	100.0

In order to compare more readily the distillation of the three samples of creosote the curves have been plotted in figure 24. Bearing in mind that samples B and C were distilled in a common flask and that sample A was distilled in a Hempel flask, these curves indicate that there was little difference between the two samples taken from the storage tank at different times. On the other hand there is a fairly constant variation between the second sample from the storage tank and that from the measuring tank. Since the oil in the measuring tank had not been changed except by addition

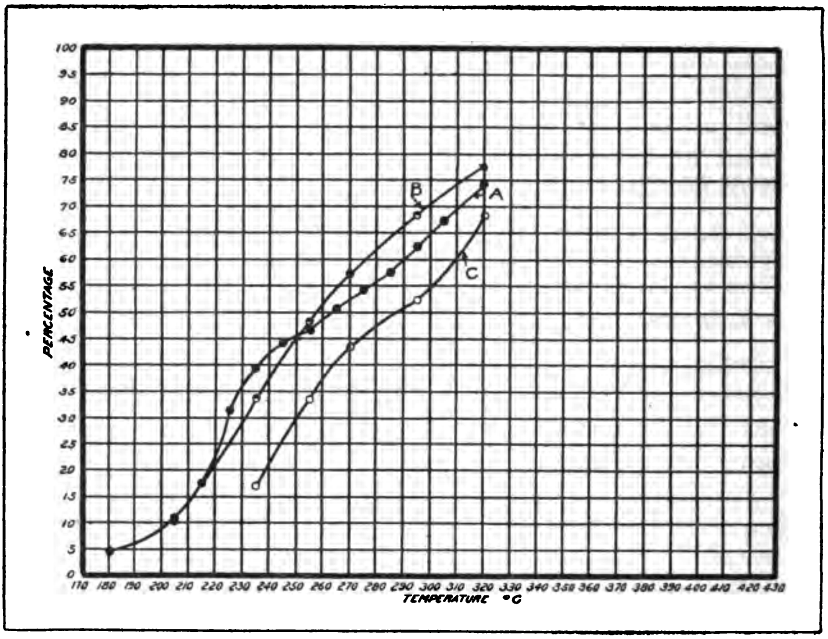


FIG. 24.—Comparison of distillation curves for three samples of creosote; A, taken from storage tank before beginning of treatment; B, taken from storage tank during progress of treatment; C, taken from measuring tank at same time B was taken from storage tank.

of amounts equivalent to the oil consumed during treatment, and the oil in the storage tank was much less subject to volatilization than that employed during the treatments, it appears probable that this difference is due to the partial loss of the naphthalenes. This supposition is borne out by a comparison of the specific gravities of the three samples—1.055 in the case of the sample taken from the measuring tank, and 1.048 and 1.044, respectively, in the case of the two samples from the storage tank.

ZINC CHLORID.

The zinc chlorid used in the treatment of the ties was obtained under the following specifications:

The fused zinc chlorid must contain at least 94 per cent of water-soluble chlorid of zinc, and it must be slightly basic; that is, contain no free acids. It should be practi-

cally free from soluble iron, and in no case will it have more than 0.022 per cent of this element. It shall not contain more than one-half of 1 per cent of other inorganic impurities insoluble in hydrochloric acid.

A sufficient analysis was made to ascertain that the preservative used fully complied with the specifications.

GAS-HOUSE OIL.[1]

A sample of the semirefined oil with paraffin base, commonly known as "gas-house oil," was taken just previous to its use in the treatments. The analysis was made by the regular Forest Service field method for analyzing creosote with the following result:

Date of analysis, May 12, 1911.
Specific gravity at 60° C. (by hydrometer), 0.837.
Flash point, —105° C.
Burning point, —126° C.
Character, dark liquid.

TABLE 11.—*Distillation record of "gas-house oil."*

No.	Temperature.	Distillate.	
		Observed.	Cumulative.
	° C.	*Per cent.*	*Per cent.*
1	190	0.0	....
2	200	6.0	6.0
3	230	2.0	8.0
4	250	1.0	9.0
5	265	3.0	12.0
6	275	4.5	16.5
7	290	8.5	25.0
8	300	8.5	33.5
9	310	9.0	42.5
10	320	8.0	50.5
11	330	8.5	59.0
12	340	7.8	66.8
13	350	8.2	75.0
14	360	6.5	81.5
15	365	3.8	85.3
Residue (by difference)	....	14.7	100.0

REMARKS.—All of the fractions were liquid at room temperature, and the residue was a black liquid.

CREOSOTE-ZINC-CHLORID EMULSIONS.

At the beginning of the treatments by the Card process the questions arose as to how best to detect any change in the emulsion used in this process caused by the ties taking up the two constituents in a different proportion from that in which they were present in the emulsion. This question resolved itself into two parts: (1) the proper sampling of the emulsion, and (2) accurate measurement of the volumes of the two constituents in the samples.

Samples of emulsion were first taken from the top, bottom, and side of the treating cylinder by means of pipes which did not extend beyond the inner surface of the shell. These differed so much from

[1] This is a crude petroleum from which the lighter portions have been removed.

each other and from the sample taken from the measuring tank at the same time that it was evident that they were not true samples. A pipe was then placed in the rear end of the cylinder and extended 2 feet into the interior, as shown in figure 25. Samples were taken nearly simultaneously from this pipe and from the measuring tank. Care was taken to let the emulsion flow long enough to be certain that the sampling pipe had been entirely emptied of stagnant fluid before the sample from the cylinder was drawn off. A true sample of the emulsion could not be obtained from the cylinder until the centrifugal pump had been in operation for some time.

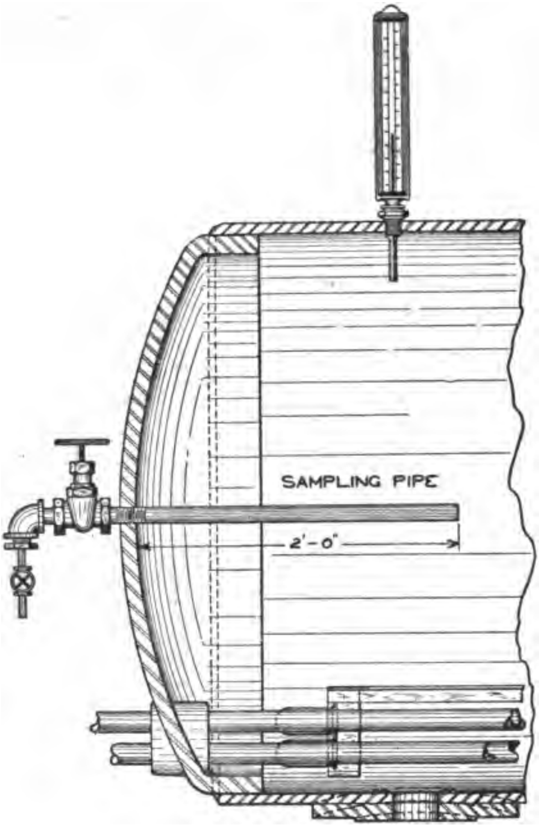


FIG. 25.—Device used for sampling creosote-zinc-chlorid emulsions in Card process.

The method finally adopted for determining the proportions of zinc-chlorid solution and creosote in the samples of emulsion was that of separating the water from the creosote by distillation. Water-saturated xylol was added to the emulsion to assist in the separation.[1]

It was found that the proportion of zinc-chlorid solution in the emulsion was less than 80 per cent at the end of a treatment of either the red-oak or hard-maple ties, although the proportion was brought up to 80 per cent at the beginning of each treatment. The proportions in both cases are based on volume at approximately 70° F. The amount of the decrease of the zinc-chlorid solution was not the same in different cylinder charges, but varied considerably.

[1] This method is explained more fully in Forest Service Circular 134, The Estimation of Moisture in Creosoted Wood, by Arthur L. Dean.

Table 12.—*Specific gravity of 2½ and 3 per cent $ZnCl_2$ solution in pure water at different temperatures.*[1]

Temperature.	Specific gravity.	
	2.5 per cent solution at 60° F.	3 per cent solution at 60° F.
° *F.*		
60	1.0231	1.0274
80	1.0203	1.0245
100	1.0166	1.0207
120	1.0118	1.0159
140	1.0064	1.0103
160	1.0004	1.0043
180	.9937	.9972
200	.9864	.9899

[1] This table is accurate to 1 in the fourth decimal place up to 140° F. and to 5 in the fourth decimal place beyond that point.

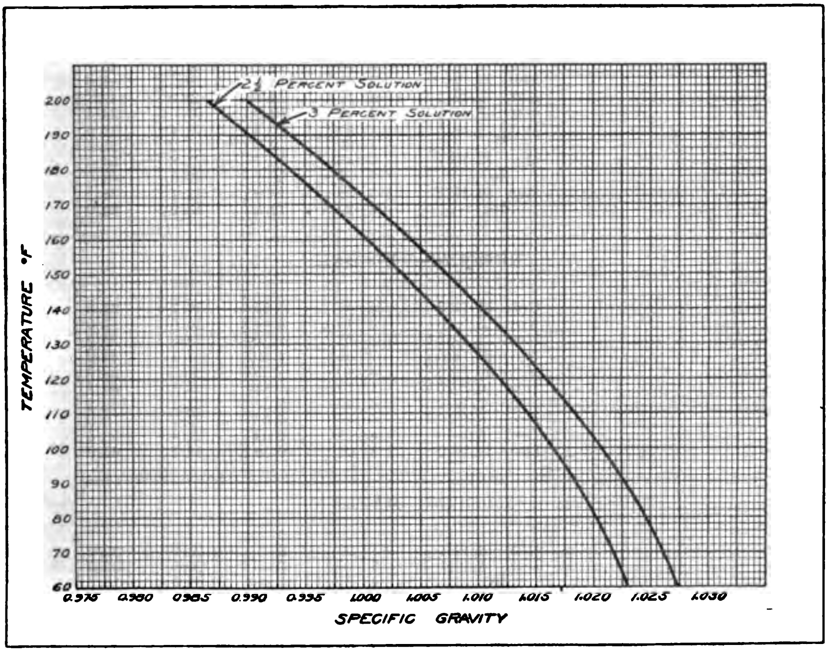


Fig. 26.—Specific gravity of 2.5 and 3 per cent solutions of zinc chlorid in pure water at different temperatures. (Plotted from Table 12.)

TABLE 13.—*Summary of results of tie treatments for each cylinder charge*

FULL-CELL CREOSOTE—RED OAK.

Charge number.	Date of treatment.	Total time of treatment.	Average absorption per cubic foot.	Variation from average absorption. Average variation.	Variation of tie of highest absorption.	Variation of tie of lowest absorption.
		Hr. min.	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*
3	Nov. 16, 1910	5 44	11.5	12.1	21.0	15.6
4, 12, 17	Nov. 18, 1910[1]	[1]6 05	[2]11.6	21.7	55.1	30.1
5, 10, 11, 16	Nov. 17, 1910[1]	[1]5 10	[2]11.7	16.7	58.0	26.4
6, 13, 14, 15	Nov. 16, 1910[1]	[1]2 30	[2]10.4	16.4	36.5	34.6
7, 18, 20	Nov. 26, 1910[1]	[1]7 00	[2]11.6	13.2	26.0	16.3
28	Dec. 13, 1910	2 20	10.0	10.6	18.0	32.0
29, 30	Dec. 14, 1910[1]	[1]4 10	[2]10.4	13.1	39.5	16.3
31	Dec. 14, 1910	4 25	10.9	21.8	61.5	48.6
32	Dec. 15, 1910	5 55	10.6	10.6	16.5	29.5
33	Dec. 16, 1910	4 20	11.1	20.3	57.7	31.5
34	.....do.......	4 05	10.2	13.4	32.3	18.7
FULL-CELL CREOSOTE—MAPLE.						
57	Feb. 21, 1911	3 35	10.7	26.8	46.7	60.5
59[1]	Feb. 28, 1911[1]	[1]2 55	[2]14.6	16.2	49.5	35.6
60	Mar. 1, 1911	2 50	14.9	19.0	47.7	35.5
63, 64[1]	Mar. 7, 1911[1]	[1]1 37	[2]9.9	21.6	34.4	36.3
74	Mar. 14, 1911	1 47	10.3	19.4	37.9	32.0
76	.....do.......	1 30	9.8	17.2	81.6	41.0
77	Mar. 15, 1911	3 48	12.7	21.8	50.5	36.2
78	.....do.......	2 26	10.2	19.3	43.0	22.5
79	Mar. 16, 1911	2 58	14.9	11.1	28.2	29.5
80	.....do.......	2 30	12.5	13.6	36.0	35.2
RUEPING—RED OAK.						
8	Oct. 31, 1910	4 45	4.95	19.7	71.8	29.3
9	Nov. 2, 1910	5 10	4.44	10.0	17.0	14.4
19	Nov. 22, 1910	3 35	5.15	14.0	25.2	28.2
21	Nov. 29, 1910	2 55	4.59	24.4	45.9	43.4
22	Nov. 30, 1910	3 40	5.89	23.3	38.5	41.2
23	Dec. 6, 1910	4 10	4.83	27.1	60.3	36.6
24	Dec. 7, 1910	4 40	5.53	21.1	58.2	66.9
25	Dec. 8, 1910	4 40	5.62	23.7	78.0	79.5
26	Dec. 9, 1910	4 45	6.03	21.4	58.4	43.8
27	Dec. 12, 1910	3 25	6.39	14.7	45.0	24.8
RUEPING—MAPLE.						
62	Mar. 6, 1911	[3]7 20	6.44	21.0	32.6	50.3
65	Mar. 8, 1911	3 26	6.40	20.0	35.5	46.2
66	.....do.......	4 25	3.68	22.5	36.7	48.4
67	Mar. 9, 1911	3 35	4.57	12.3	27.8	20.8
68	.....do.......	2 50	4.31	12.7	28.6	19.7
69	Mar. 10, 1911	3 25	5.08	18.9	32.5	35.8
70	.....do.......	4 55	4.92	20.2	38.6	34.0
71	Mar. 11, 1911	2 54	4.92	14.2	36.2	24.8
72	Mar. 13, 1911	3 33	4.42	16.4	35.8	30.3
73	.....do.......	2 00	4.04	24.6	44.0	49.0
BURNETT—RED OAK.						
35	Jan. 6, 1911	4 30	[4]13.5	14.6	26.6	26.6
36	Jan. 7, 1911	3 15	[4]16.2	10.5	17.9	15.4
38	Jan. 9, 1911	3 45	[4]16.4	15.4	40.2	30.5
39	Jan. 10, 1911	4 00	[4]15.7	11.2	15.3	28.7
40	Jan. 18, 1911	5 00	[4]17.0	13.1	31.8	40.0
41	Jan. 23, 1911	4 30	[4]16.8	21.2	53.0	45.2
42	Jan. 25, 1911	7 30	[4]17.3	16.7	34.0	26.0
43	.....do.......	5 00	[4]19.6	19.9	70.8	29.6
44	Jan. 27, 1911	5 30	[4]19.3	10.3	28.0	11.9
45	Jan. 30, 1911	4 00	[4]17.6	5.1	10.8	20.0

[1] Last re-treatment.
[2] Total average absorption.
[3] Not used in averages. Delay due to accidents during treatment.
[4] 3 per cent $ZnCl_2$ solution.

TABLE 13.—*Summary of results of tie treatments for each cylinder charge*—Continued.

BURNETT—MAPLE.

Charge number.	Date of treatment.	Total time of treatment.	Average absorption per cubic foot.	Variation from average absorption.		
				Average variation.	Variation of tie of highest absorption.	Variation of tie of lowest absorption.
		Hr. min.	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*
46	Jan. 31, 1911	[1]5 00	[2]20.7	16.0	32.9	41.6
47	Feb. 1, 1911	3 00	[2]19.2	13.5	27.0	22.4
48	Feb. 2, 1911	2 15	[2]21.8	13.5	32.0	30.8
49	Feb. 4, 1911	2 40	[2]22.3	12.8	24.2	30.9
50	Feb. 6, 1911	3 30	[2]17.9	16.4	30.0	38.5
51	Feb. 7, 1911	2 45	[2]19.6	18.6	26.0	33.7
52	Feb. 8, 1911	2 05	[2]21.8	17.7	26.7	46.3
53	Feb. 9, 1911	2 40	[2]19.6	16.8	34.1	31.1
54	Feb. 10, 1911	3 50	[2]16.9	19.6	29.0	53.2
55	Feb. 11, 1911	3 40	[2]26.0	23.2	84.8	30.8
CARD—RED OAK.						
101	Apr. 7, 1911	5 20	[3]15.2	19.6	35.5	46.7
102	Apr. 11, 1911	5 35	[3]15.2	11.1	15.8	17.8
103	do	5 50	[3]14.5	13.4	24.8	30.3
104	Apr. 12, 1911	4 25	[3]17.6	11.2	35.3	31.2
105	do	6 10	[3]14.7	9.5	13.6	17.7
106	Apr. 13, 1911	4 35	[3]14.7	15.9	27.9	32.3
107	do	5 03	[3]16.0	16.8	30.6	54.6
108	Apr. 14, 1911	6 00	[3]12.7	10.7	19.6	19.7
109, 110	Apr. 15, 1911[4]	[4]4 18	[5]14.1	15.1	22.7	28.3
111	Apr. 17, 1911	6 13	[3]18.4	13.6	24.5	28.8
CARD—MAPLE.						
112	Apr. 18, 1911	5 20	[3]13.5	32.9	54.1	58.1
113	Apr. 19, 1911	4 45	[3]16.7	14.6	28.1	30.6
114	do	4 55	[3]15.1	17.4	25.8	44.7
115	Apr. 20, 1911	3 50	[3]13.7	19.1	96.4	27.7
116	do	4 40	[3]15.1	20.5	45.1	35.1
117	Apr. 21, 1911	5 50	[3]16.4	13.1	19.5	23.8
118	Apr. 24, 1911	4 45	[3]17.9	21.6	45.2	29.6
119	Apr. 25, 1911	5 05	[3]17.7	23.2	42.4	26.5
120	do	3 52	[3]16.3	26.2	45.4	32.8
121	Apr. 26, 1911	5 00	[3]17.6	17.2	49.0	42.6
TWO-MOVEMENT CREOSOTE-ZINC CHLORID—RED OAK.						
81	Mar. 20, 1911	[6]7 00	[7]15.1	15.2	50.4	35.6
82	Mar. 21, 1911	3 50	[7]15.7	12.6	22.3	22.3
83	do	3 39	[7]13.0	16.6	30.8	26.9
84	Mar. 22, 1911	4 22	[7]14.4	13.9	34.7	41.0
85	do	3 22	[7]14.8	14.8	35.8	26.3
86	Mar. 23, 1911	4 15	[7]18.5	10.3	24.3	17.8
87	do	3 35	[7]12.8	9.7	23.5	25.8
88	Mar. 24, 1911	4 15	[7]16.1	12.7	33.0	33.6
89	do		[7]17.1	7.6	16.4	20.5
90	Mar. 27, 1911	4 45	[7]15.5	9.1	14.2	28.4
TWO-MOVEMENT CREOSOTE-ZINC CHLORID—MAPLE.						
91	Mar. 27, 1911	3 40	[7]13.4	24.8	36.6	38.0
92	Mar. 28, 1911	4 45	[7]16.6	30.0	58.5	54.2
93	do	3 40	[7]17.4	10.2	15.5	30.5
94	Mar. 29, 1911	3 40	[7]16.0	20.3	39.4	45.6
95	Mar. 31, 1911	3 45	[7]16.3	11.0	16.0	27.6
96	do	5 53	[7]13.9	21.4	41.7	46.0
97	Apr. 1, 1911	3 02	[7]14.9	15.1	24.8	50.5
98	Apr. 3, 1911	3 41	[7]17.7	9.3	16.4	17.5
99	do	4 00	[7]12.5	14.8	24.9	39.2
100	Apr. 4, 1911	4 50	[7]16.7	14.3	18.6	27.6

[1] Not used in averages.
[2] 2½ per cent $ZnCl_2$ solution.
[3] Emulsion of 80 parts of 3 per cent $ZnCl_2$ solution and 20 parts of creosote by volume at approximately 70° F.
[4] Last re-treatment.
[5] Total average absorption.
[6] Not used in averages. Delay due to accidents during treatment.
[7] 3 per cent $ZnCl_2$ solution + creosote.

TABLE 13.—*Summary of results of tie treatments for each cylinder charge*—Continued.

GAS-HOUSE OIL—RED OAK.

Charge number.	Date of treatment.	Total time of treatment.	Average absorption per cubic foot.	Variation from average absorption.		
				Average variation.	Variation of tie of highest absorption.	Variation of tie of lowest absorption.
		Hr. min.	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*
122	Apr. 26, 1911	3 15	5.15	30.5	86.4	36.7
123	Apr. 27, 1911	6 34	11.08	15.6	36.7	37.5
124	.....do.......	4 10	11.50	10.8	19.1	19.1
125	Apr. 28, 1911	3 40	7.40	45.4	81.5	71.6
132	May 2, 1911	4 36	7.16	21.2	52.2	43.8
133	May 3, 1911	5 00	6.65	18.6	39.8	30.5
134	.....do.......	4 10	5.17	34.2	81.9	61.1
135	May 4, 1911	5 05	6.40	22.8	29.0	70.8
136	.....do.......	4 00	5.78	37.2	73.0	67.8
137	May 5, 1911	4 45	6.75	35.4	49.5	64.1

GAS-HOUSE OIL—MAPLE.

Charge number.	Date of treatment.	Total time of treatment.	Average absorption per cubic foot.	Average variation.	Variation of tie of highest absorption.	Variation of tie of lowest absorption.
126	Apr. 28, 1911	4 27	14.8	21.2	33.1	46.1
127	Apr. 29, 1911	4 00	8.7	50.2	85.0	84.2
128	May 1, 1911	3 55	10.1	35.1	53.5	61.6
129	.....do.......	3 05	11.0	26.1	52.7	48.9
130	.....do.......	3 10	10.2	17.7	32.4	34.4
131	May 2, 1911	4 15	13.8	13.0	29.0	23.2
138	May 5, 1911	3 00	14.8	17.4	50.7	42.6
139	May 6, 1911	3 20	14.6	22.9	50.0	33.6
140	May 8, 1911	3 41	13.7	11.7	28.5	18.2
141	.....do.......	3 10	14.3	17.3	53.2	26.5

TABLE 14.—*Amount of zinc chlorid in the ties of average absorption.*

BURNETT TREATMENT—RED OAK.

Tie No.	Cylinder charge No.	Absorption, dry salt per cubic foot.		Difference between check analyses.	Difference between calculated absorption for tie and absorption determined in section.
		Calculated from amount of solution absorbed by tie.	Determined by analysis of section 2 feet from end of tie.		
		Pounds.	*Pounds.*	*Pounds. per cu. ft.*	*Per cent.*[1]
204	35	0.44	0.43	0.010	2.3
225	38	.49	.34	.010	30.6
238	39	.49	.37	.020	24.5
242	40	.51	.55	.020	−7.8
251	41	.50	.42	.020	16.0
266	42	.53	.41	.010	22.6
271	43	.61	.58	.020	49.2
283	44	.59	.60	.010	−1.7
291	45	.53	.34	.010	35.8

[1] Based on calculated absorptions for the ties.

TABLE 14.—*Amount of zinc chlorid in the ties of average absorption*—Continued.

BURNETT TREATMENT—MAPLE.

Tie No.	Cylinder charge No.	Absorption, dry salt per cubic foot. Calculated from amount of solution absorbed by tie.	Absorption, dry salt per cubic foot. Determined by analysis of section 2 feet from end of tie.	Difference between check analyses.	Difference between calculated absorption for tie and absorption determined in section.
		Pounds.	*Pounds.*	*Pounds. per cu. ft.*	*Per cent.*
305	46	0.37	0.28	0.010	24.3
326	48	.47	.40	.010	14.9
339	49	.54	.45	.010	16.8
350	50	.44	.29	.010	34.1
360	51	.48	.31	.010	35.4
364	52	.58	.41	.010	29.3
372	53	.49	.33	.010	32.6
381	54	.40	.34	.020	15.0
392	55	.65	.39	.010	40.0
CARD TREATMENT—RED OAK.					
1204	101	0.37	0.35	0.010	5.4
1220	102	.40	.34	.010	15.6
1223	103	.37	.32	.010	12.3
1232	104	.44	.21	.010	52.6
1244	105	.40	.34	.010	14.6
1253	106	.39	.36	.010	7.7
1263	107	.41	.40	.010	1.2
1275	108	.34	.33	.010	2.4
CARD TREATMENT—MAPLE.					
1117	113	0.42	0.29	0.010	31.4
1130	114	.36	.25	.004	30.8
1136	115	.35	.15	.010	56.5
1144	116	.38	.21	.010	44.8
1157	117	.38	.31	.010	19.0
1165	118	.40	.47	.010	17.5
1178	119	.39	.27	.010	30.4
1188	120	.36	.24	.010	32.4
1195	121	.41	.39	.007	6.5
TWO-MOVEMENT CREOSOTE-ZINC-CHLORID TREATMENT—RED OAK.					
801	81	(1)	0.25	0.003	....
812	82	(1)	.31	.003	....
829	83	(1)	.26	.004	....
836	84	(1)	.23	.004	....
843	85	(1)	.31	.004	....
856	86	(1)	.27	.007	....
863	87	(1)	.22	.004	....
878	89	(1)	.37	.003	....
885	88	(1)	.23	.010	....
894	90	(1)	.21	.007	....
TWO-MOVEMENT CREOSOTE-ZINC-CHLORID TREATMENT—MAPLE.					
1003	91	(1)	0.18	0.010	....
1016	92	(1)	.31	.004	....
1021	93	(1)	.31	.007	....
1034	94	(1)	.36	.004	....
1049	95	(1)	.31	.003	....
1055	96	(1)	.33	.004	....
1067	97	(1)	.45	.007	....
1072	98	(1)	.31	.007	....
1089	99	(1)	.26	.006	....
1100	100	(1)	.17	.004	....

[1] The calculated values are not given, as the absorptions indicated by the gauge readings did not agree with the absorptions indicated by weights for the individual cylinder charges.

TABLE 15.—*Data on the average seasoning after treatment of each cylinder charge of ties.*

Charge No.	Date of treatment.	Date of reweighing.	Time seasoned.	Average moisture.	Average weight of ties. Directly after treatment.	Average weight of ties. Before laying in track.	Average loss in weight per cubic foot.	Average absorption per cubic foot.	Average loss of weight after treatment.[1]
			Days.	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*
FULL-CELL CREOSOTE—RED OAK.									
16[2]	Nov. 17, 1910	June 20, 1911	215	49.4	179.4	173.1	2.26	[3] 11.74	19.2
3	Oct. 16, 1910	do	214	42.6	181.0	177.0	1.49	10.70	13.9
20[2]	Nov. 26, 1910	do	204	41.5	184.5	179.5	1.76	[3] 11.34	15.5
15[2]	Nov. 16, 1910	do	214	43.7	173.5	168.1	1.97	[3] 10.52	18.7
17[2]	Nov. 18, 1910	do	212	41.0	203.2	195.8	2.49	[3] 11.76	21.2
28	Dec. 13, 1910	do	189	46.2	196.3	189.2	2.33	9.94	23.4
30[2]	Dec. 14, 1910	do	188	48.2	200.6	193.3	2.35	[3] 10.28	22.8
31	do	do	188	39.3	163.0	157.7	2.15	11.50	18.7
32	Dec. 15, 1910	do	187	45.5	167.6	160.3	2.85	10.63	26.8
33	Dec. 16, 1910	do	186	49.7	169.6	166.6	1.13	11.08	10.2
FULL-CELL CREOSOTE—MAPLE.									
57	Feb. 21, 1911	June 22, 1911	121	37.6	196.3	190.5	1.73	10.69	16.2
59[2]	Feb. 28, 1911	do	114	36.2	195.4	189.6	1.83	[3] 15.15	12.1
60	Mar. 1, 1911	do	113	31.1	183.2	178.2	1.60	14.76	10.8
64[2]	Mar. 7, 1911	do	107	28.9	170.6	165.7	1.54	[3] 10.03	15.3
76	Mar. 14, 1911	do	100	32.3	167.2	163.7	1.19	10.14	11.7
74	do	do	100	30.2	178.2	172.9	1.65	10.25	16.1
77	Mar. 15, 1911	do	99	30.7	191.9	188.4	1.09	13.47	8.1
78	do	do	99	29.7	182.5	179.4	1.00	10.77	9.3
79	Mar. 16, 1911	do	98	34.6	206.5	199.2	2.19	14.60	15.0
80	do	do	98	31.1	165.2	158.2	2.51	12.77	19.7
RUEPING—RED OAK.									
8	Oct. 31, 1910	June 20, 1911	232	46.6	170.4	160.9	3.48	5.24	66.4
9	Nov. 2, 1910	do	230	45.7	131.0	126.2	2.15	4.37	49.2
19	Nov. 22, 1910	do	210	47.2	137.2	132.1	2.22	5.14	43.2
21	Nov. 29, 1910	do	203	49.6	174.2	165.1	3.14	4.62	68.0
22	Nov. 30, 1910	do	202	37.4	154.0	147.6	2.37	5.88	40.3
23	Dec. 6, 1910	do	196	39.3	124.1	117.9	2.82	4.80	58.7
24	Dec. 7, 1910	do	195	54.3	199.9	189.6	3.14	5.97	52.6
25	Dec. 8, 1910	do	194	37.3	145.4	138.2	3.07	5.63	54.5
26	Dec. 9, 1910	do	193	44.6	165.2	157.5	2.84	5.79	49.1
27	Dec. 12, 1910	do	190	50.7	148.4	140.5	3.25	6.48	50.1
RUEPING—MAPLE.									
65	Mar. 8, 1911	June 22, 1911	106	31.5	144.7	141.7	0.95	6.40	14.8
66	do	do	106	29.9	149.7	147.2	.83	3.63	22.9
67	Mar. 9, 1911	do	105	30.0	155.1	150.8	1.37	4.58	29.9
62	Mar. 6, 1911	do	108	29.6	151.6	146.3	1.82	6.42	28.3
68	Mar. 9, 1911	do	105	31.8	154.8	151.6	1.05	4.30	24.4
69	Mar. 10, 1911	do	104	30.2	157.0	152.5	1.42	5.26	27.0
70	do	do	104	26.2	154.2	151.6	0.80	5.02	13.9
71	Mar. 11, 1911	do	103	36.5	157.6	154.2	1.06	4.88	21.7
72	Mar. 13, 1911	do	101	36.4	162.5	159.3	1.01	4.43	18.6
73	do	do	101	28.0	141.0	138.1	1.04	4.06	25.6

[1] Based on the absorption. [2] Re-treatment. [3] Total average absorption.

Table 15.—*Data on average seasoning after treatment of each cylinder charge of ties*—Contd.

BURNETT—RED OAK.

Charge No.	Date of treatment.	Date of reweighing.	Time seasoned.	Average moisture.	Average weight of ties. Directly after treatment.	Average weight of ties. Before laying in track.	Average loss in weight per cubic foot.	Average absorption per cubic foot.	Average loss of weight after treatment.
			Days.	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*
35	Jan. 6, 1911	June 21, 1911	166	43.0	172.1	147.8	9.57	[1] 14.04	68.2
36	Jan. 7, 1911	do	165	45.5	197.6	167.7	10.50	[1] 16.51	63.6
38	Jan. 9, 1911	do	163	46.7	211.2	179.6	10.47	[1] 16.45	63.7
39	Jan. 10, 1911	do	162	44.7	209.1	185.5	7.62	[1] 15.72	48.5
40	Jan. 18, 1911	do	154	44.9	189.4	161.5	10.32	[1] 16.96	60.9
41	Jan. 23, 1911	do	149	44.1	171.4	142.5	11.55	[1] 16.85	68.6
42	Jan. 25, 1911	do	147	42.8	166.7	143.2	10.02	[1] 17.43	57.5
43	do	do	147	41.8	201.2	169.8	11.41	[1] 17.60	58.3
44	Jan. 27, 1911	do	145	37.7	211.7	178.7	11.20	[1] 19.01	58.9
45	Jan. 30, 1911	do	142	43.6	193.0	163.9	10.60	[1] 17.52	60.5

BURNETT—MAPLE.

Charge No.	Date of treatment.	Date of reweighing.	Time seasoned.	Average moisture.	Directly after treatment.	Before laying in track.	Average loss in weight per cubic foot.	Average absorption per cubic foot.	Average loss of weight after treatment.
46	Jan. 31, 1911	June 21, 1911	141	41.9	215.3	166.9	14.80	[2] 21.16	70.0
47	Feb. 1, 1911	do	140	34.6	196.7	154.7	14.12	[2] 19.06	74.1
48	Feb. 2, 1911	do	139	29.4	195.6	147.1	16.00	[2] 22.05	72.6
49	Feb. 4, 1911	do	137	35.1	226.2	163.6	18.98	[2] 21.97	86.4
50	Feb. 6, 1911	do	135	31.9	189.5	148.6	13.28	[2] 17.36	76.5
51	Feb. 7, 1911	do	134	33.8	199.6	150.1	16.53	[2] 19.10	86.6
52	Feb. 8, 1911	do	133	33.5	212.1	158.3	17.31	[2] 21.63	80.0
53	Feb. 9, 1911	do	132	39.1	208.6	164.5	14.08	[2] 19.55	72.0
54	Feb. 10, 1911	do	131	37.2	192.0	150.7	13.82	[2] 16.90	81.8
55	Feb. 11, 1911	do	130	39.0	225.5	167.5	17.95	[2] 23.40	76.7

CARD—RED OAK.

Charge No.	Date of treatment.	Date of reweighing.	Time seasoned.	Average moisture.	Directly after treatment.	Before laying in track.	Average loss in weight per cubic foot.	Average absorption per cubic foot.	Average loss of weight after treatment.
101	Apr. 7, 1911	June 26, 1911	80	42.8	183.4	163.2	7.43	[3] 15.61	47.6
102	Apr. 11, 1911	do	76	42.6	186.2	157.3	10.28	[3] 15.11	68.0
103	do	do	76	35.5	173.8	152.4	8.20	[3] 13.08	62.7
104	Apr. 12, 1911	do	75	38.4	209.0	177.9	10.18	[3] 18.22	55.9
105	do	do	75	39.8	194.1	176.2	6.02	[3] 14.55	41.4
106	Apr. 13, 1911	do	74	40.8	198.2	179.0	6.37	[3] 14.63	43.5
107	do	do	74	37.1	178.3	164.1	5.08	[3] 15.99	31.8
108	Apr. 14, 1911	do	73	36.1	183.0	165.5	6.01	[3] 12.82	46.9
110 [4]	Apr. 15, 1911	do	72	47.8	168.6	151.8	6.82	[5] 14.15	48.2
111	Apr. 17, 1911	do	70	38.7	190.3	162.5	9.05	[3] 18.43	49.1

CARD—MAPLE.

Charge No.	Date of treatment.	Date of reweighing.	Time seasoned.	Average moisture.	Directly after treatment.	Before laying in track.	Average loss in weight per cubic foot.	Average absorption per cubic foot.	Average loss of weight after treatment.
112	Apr. 18, 1911	June 26, 1911	69	32.5	171.1	147.1	8.67	[3] 13.49	64.3
113	Apr. 19, 1911	do	68	27.4	178.7	158.3	6.86	[3] 16.66	41.2
114	do	do	68	31.3	187.9	170.2	5.86	[3] 15.47	37.9
115	Apr. 20, 1911	do	67	34.0	194.6	178.5	5.04	[3] 12.54	40.2
116	do	do	67	31.9	192.1	174.3	5.84	[3] 15.50	37.7
117	Apr. 21, 1911	do	66	32.2	195.7	169.9	8.37	[3] 16.48	50.8
118	Apr. 24, 1911	do	63	30.2	192.8	170.7	7.43	[3] 18.05	41.2
119	Apr. 25, 1911	do	62	31.8	213.6	184.3	8.65	[3] 17.86	48.4
120	do	do	62	30.7	217.1	189.6	8.10	[5] 16.51	49.1
121	Apr. 26, 1911	do	61	30.7	194.0	160.5	11.05	[5] 18.68	59.2

[1] 3 per cent $ZnCl_2$ solution.
[2] 2½ per cent $ZnCl_2$ solution.
[3] Emulsion of 80 parts of 3 per cent $ZnCl_2$ solution and 20 parts of creosote at approximately 70° F.
[4] Re-treatment.
[5] Total average absorption.

TABLE 15.—*Data on average seasoning after treatment of each cylinder charge of ties*—Contd.

TWO-MOVEMENT CREOSOTE-ZINC CHLORID—RED OAK.

Charge No.	Date of treatment.	Date of reweighing.	Time seasoned.	Average moisture.	Average weight of ties. Directly after treatment.	Average weight of ties. Before laying in track.	Average loss in weight per cubic foot.	Average absorption per cubic foot.	Average loss of weight after treatment.
			Days.	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*
81	Mar. 20, 1911	June 23, 1911	95	34.8	185.0	167.0	6.40	[1] 15.78	40.5
82	Mar. 21, 1911	do	94	40.1	175.2	150.4	9.52	[1] 15.55	61.2
83	do	do	94	41.4	180.8	162.5	6.52	[1] 12.87	50.6
84	Mar. 22, 1911	do	93	45.7	192.7	169.6	8.18	[1] 14.41	56.8
85	do	do	93	40.8	179.6	157.5	8.24	[1] 14.75	55.9
86	Mar. 23, 1911	do	92	34.4	194.8	168.1	9.37	[1] 18.35	51.0
87	do	do	92	48.6	196.0	175.1	7.23	[1] 12.73	56.8
88	Mar. 24, 1911	do	91	39.0	204.2	184.7	6.42	[1] 17.00	37.7
89	do	do	91	46.5	217.8	182.4	11.17	[1] 16.02	69.8
90	Mar. 27, 1911	do	88	41.9	204.2	172.1	10.40	[1] 15.47	67.2

TWO-MOVEMENT CREOSOTE-ZINC CHLORID—MAPLE.

Charge No.	Date of treatment.	Date of reweighing.	Time seasoned.	Average moisture.	Directly after treatment.	Before laying in track.	Average loss in weight per cubic foot.	Average absorption per cubic foot.	Average loss of weight after treatment.
91	Mar. 27, 1911	June 24, 1911	89	29.6	168.5	148.8	6.96	[1] 14.83	46.9
92	Mar. 28, 1911	do	88	30.9	185.8	154.9	10.42	[1] 17.56	59.4
93	do	do	88	31.3	178.1	153.2	8.78	[1] 17.44	50.3
94	Mar. 29, 1911	do	87	29.4	180.0	154.3	8.65	[1] 15.88	54.4
95	Mar. 31, 1911	do	85	34.7	195.2	166.3	9.40	[1] 16.32	57.6
96	do	do	85	31.7	199.0	172.4	7.90	[1] 13.66	57.8
97	Apr. 1, 1911	do	84	30.9	200.2	169.7	9.19	[1] 14.85	61.9
98	Apr. 3, 1911	do	82	36.1	222.8	185.1	10.98	[1] 17.75	61.9
99	do	do	82	32.5	172.6	148.0	8.34	[1] 12.51	66.7
100	Apr. 4, 1911	do	81	31.3	187.6	148.5	12.85	[1] 16.71	76.9

GAS-HOUSE OIL—RED OAK.

Charge No.	Date of treatment.	Date of reweighing.	Time seasoned.	Average moisture.	Directly after treatment.	Before laying in track.	Average loss in weight per cubic foot.	Average absorption per cubic foot.	Average loss of weight after treatment.
122	Apr. 26, 1911	June 23, 1911	58	55.8	171.3	164.1	2.51	5.13	48.9
123	Apr. 27, 1911	do	57	46.0	187.8	181.3	2.24	11.56	19.4
124	do	do	57	44.5	177.3	172.3	1.82	11.46	15.9
125	Apr. 28, 1911	do	56	53.2	172.3	167.4	1.80	7.42	24.3
132	May 2, 1911	do	52	46.8	170.3	163.4	2.50	7.12	35.1
133	May 3, 1911	do	51	56.0	185.0	177.2	2.63	6.66	39.5
134	do	do	51	53.6	157.8	151.1	2.61	5.16	50.6
135	May 4, 1911	do	50	50.5	170.5	163.1	2.68	6.40	41.9
136	do	do	50	52.3	175.2	169.8	1.91	5.73	33.3
137	May 5, 1911	do	49	47.5	164.8	156.2	3.31	7.07	46.8

GAS-HOUSE OIL—MAPLE.

Charge No.	Date of treatment.	Date of reweighing.	Time seasoned.	Average moisture.	Directly after treatment.	Before laying in track.	Average loss in weight per cubic foot.	Average absorption per cubic foot.	Average loss of weight after treatment.
126	Apr. 28, 1911	June 24, 1911	57	30.5	204.7	201.9	0.86	14.94	5.8
127	Apr. 29, 1911	do	56	33.4	153.4	151.5	.72	8.75	8.2
128	May 1, 1911	do	54	33.3	159.7	156.4	1.20	10.10	11.9
129	do	do	54	36.2	179.7	175.5	.81	11.01	7.4
130	do	do	54	31.3	188.0	185.5	.76	10.25	7.4
131	May 2, 1911	do	53	30.4	182.4	178.3	1.37	13.78	9.9
138	May 5, 1911	do	50	33.4	210.4	206.4	1.20	14.74	8.1
139	May 6, 1911	do	49	34.3	190.6	187.9	.89	14.74	6.0
140	May 8, 1911	do	47	30.8	198.7	193.8	1.55	13.74	11.3
141	do	do	47	33.5	202.8	198.5	1.66	14.50	11.4

[1] 3 per cent $ZnCl_2$ solution + creosote.

ADDITIONAL COPIES of this publication may be procured from the SUPERINTENDENT OF DOCUMENTS, Government Printing Office, Washington, D. C., at 20 cents per copy